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Handbook

for Estimating the Socio-economic and Environmental Effects
of **Disasters**

Economic Commission for Latin America and the Caribbean
ECLAC

ORIGINAL: SPANISH

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I n t r o d u c t i o n

I. BACKGROUND

Disasters have a major impact on the living conditions, economic performance and environmental assets and services of affected countries or regions. Consequences may be long term and may even irreversibly affect economic and social structures and the environment. In industrialized countries, disasters cause massive damage to the large stock of accumulated capital while losses of human life are limited thanks, among other factors, to the availability of effective early warning and evacuation systems, as well as better urban planning and the application of strict building codes and standards. In developing countries, on the other hand, fatalities are usually higher owing to the lack or inadequacy of forecast and evacuation programmes. Although capital losses might be smaller in absolute terms when compared to those in developed countries, their relative weight and overall impact tend to be very significant, even affecting sustainability.¹

Whether disasters are essentially natural or man-made in origin, their consequences derive from a combination of human action and interaction with nature's cycles or systems. Disasters occur frequently around the world, and their incidence and intensity seem to be increasing in recent years. They can lead to widespread loss of life, directly and indirectly (primarily or secondarily) affect large segments of the population and cause significant environmental damage and large-scale economic and social harm.

In fact, recent ECLAC estimates show that in the last three decades more than 150 million people have been affected by disasters in Latin America and the Caribbean, including more than 12 million direct victims and 108,000 deaths. Moreover, total damage –and this was not an exhaustive estimate for the whole region– amounted to more than 50,000 million 1998 dollars, concentrated in the smallest and relatively less developed countries, especially in Central America, the Caribbean and the Andean sub-regions.² (See Figure 1 below).

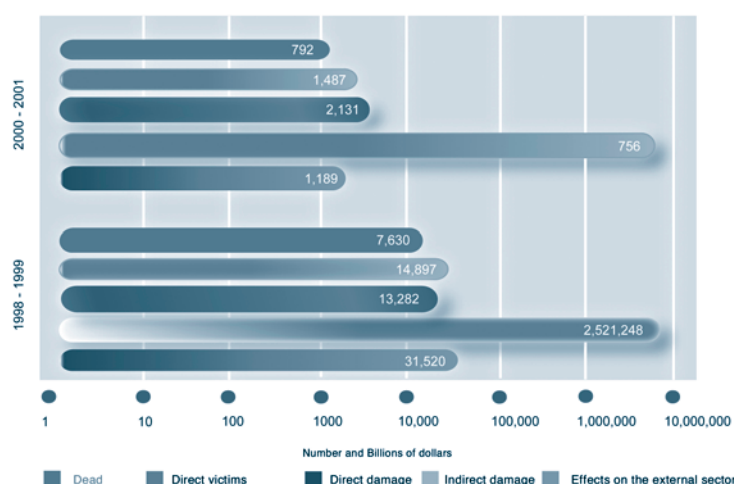
Globally, statistics show that disasters cause more socially significant and irreversible damage in developing countries, where the poorest and most vulnerable population groups feel the most severe impact. In the developed world, on the other hand, an increasing and significant degree of protection against disasters has been achieved over the years thanks to the availability of resources and technology for the introduction of effective prevention, mitigation and planning measures, together with vulnerability reduction schemes. Even in these countries however, damages have risen significantly as a result of the greater concentration and value of societal activities.

¹ Jovel, Roberto, "Natural Disasters and Their Economic and Social Impact", *ECLAC Review*, No. 38, Santiago, Chile, August 1989.

² See ECLAC and IDB, *Un tema de desarrollo: La reducción de la vulnerabilidad frente a los desastres*, Mexico City and Washington, 2000.

Some progress has been achieved in the field of planning, prevention and mitigation in Latin America and the Caribbean, but large segments of the population still live in highly precarious and vulnerable conditions. Most of the countries in the region are in areas that are prone to hydro-meteorological and geological phenomena that have produced well-known instances of widespread loss of human life and significant damage to physical and social infrastructure, while undermining economic performance and the environment.

Figure 1
LATIN AMERICA AND THE CARIBBEAN; EFFECTS OF DISASTERS (1998-2001)



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Undesirable disaster effects may include damage to economic and social infrastructure, environmental modifications, fiscal and foreign sector imbalances, price increases, modifications to demographic structures and changes in development priorities as the task of replacing lost or damaged assets results in the deferment of projects intended to overcome long-standing needs. The most devastating impact is undoubtedly the deterioration in the social well-being of the population, especially among the poorest and most vulnerable population groups. Furthermore, the ramifications of disasters increasingly extend beyond the affected community or country through unexpected population migration, disease transmission, trade reductions or widespread environmental modifications.

To reduce the long-term effects of disasters, affected countries must take actions along parallel tracks. First, as an integral part of their economic and social development strategy, they should assign financial resources for the prevention and mitigation of the foreseeable impact of a disaster. Such a commitment should be understood as a high-yield investment –in economic, social and political terms– for achieving long-term growth. Second, once a disaster has occurred, they must ensure that reconstruction investments contemplate vulnerability-reduction features to favor an adequate level of sustainable growth.

When a disaster occurs, national-emergency bodies are generally in charge of assessing humanitarian needs during the emergency stage, with support from the United Nations System and other public and private international organizations. It is now standard practice for the affected community or country to take the most essential steps to meet humanitarian requirements arising from the emergency. In addition, friendly countries and international organizations either directly or through non-governmental organizations. Promptly provide additional assistance as needed, both public and private agents take part in this effort, along with many local, regional and international non-governmental or social assistance organizations.

Reconstruction of damaged or destroyed assets, however, normally requires resources well beyond those available during the emergency or humanitarian assistance stage or otherwise within reach of the affected country. As a result, reconstruction is often undertaken without vulnerability reduction. To put it bluntly, vulnerability is reconstructed instead of being reduced.

To avoid this, immediately after the emergency stage, an assessment must be made of the direct and indirect effects of the event and their consequences on the social well-being and economic performance of the affected country or area. This assessment need not entail the utmost quantitative precision, but it must be comprehensive in that it covers the complete range of effects and their cross-implications for economic and social sectors, physical infrastructure and environmental assets. With such estimates in hand, it is possible to determine the extent of reconstruction requirements, which is an, urgent task since those affected cannot wait long under the conditions prevailing after a disaster occurs. Such an exercise is indispensable for identifying and undertaking reconstruction programme and projects, many of which will require the international community's financial and technical cooperation.

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To ensure vulnerability reduction, reconstruction programme and projects must be designed within a mitigation and prevention strategy that is part of the development process. Therefore, a set of diagnostic tools is needed to measure the type and amount of damage and losses caused by each type of disaster. Such working tools are not very abundant in the economic literature, especially since they must be able to gauge social, economic and environmental effects.

Based on special disaster-assessment endeavors in the region since the early 1970s, the Economic Commission for Latin America and the Caribbean (ECLAC) developed an assessment methodology that further broadened and developed the concepts outlined by UNDRO a decade earlier.³

3 ECLAC, *Handbook for the Estimation of the Socio-economic Effects of Natural Disasters*, Santiago, Chile, 1991; UNDRO, *Disaster Prevention and Mitigation: Compendium of Current Knowledge*, Volume 7, "Economic Aspects," United Nations, New York, 1979.

The methodology published by ECLAC at that time made it possible to estimate the effects of natural disasters; it was also applicable to man-made ones, as in the case of certain armed conflicts in Central America. In the original ECLAC Handbook, disaster effects are measured at the sectoral and global levels, thus allowing for an assessment of the reconstruction capacity of the affected country or region and the scope of the necessary international cooperation. The ECLAC methodology pays due consideration to the prevailing insufficiency of reliable quantitative information for the region, the availability of which is even more limited after a disaster. The ECLAC Handbook did not include methods for estimating damage and losses in certain social and economic sectors, to the environment or to specific population groups.

ECLAC now presents a revised and extended version of the Handbook that incorporates the practical experience acquired through the assessment of numerous disasters in the past decade, as well as the development of new and complementary concepts. This new version has also greatly benefited from the cooperation and contributions of distinguished experts and consultants from Latin America, the Caribbean and other parts of the world, and it is the result of the conceptual analyses of many disasters that have occurred in the region over the past three decades.⁴

viii This revised Handbook incorporates new and significant developments while refining and improving the methodology for damage assessment contained in several sections included in the first version published in 1991. In that respect, special reference should be made to the inclusion of cross-sectoral subject areas such as the environment, employment and income, and the differential effects on women, whose action is essential both during reconstruction and in mitigating the future impact of disasters. Furthermore, we put forward new tools for this type of analysis, which are now available thanks to the databases that can be accessed over the Internet, the use of remote sensors and the systematization of geo-referenced information. The Handbook points to some analytical difficulties associated with lags in the compilation of sufficiently detailed or itemized information –for example by sex, by income group or by geographic or political areas within a country– or the lack of baselines defining "normal" or pre-disaster situations such as environmental situation diagnoses and human development and social fabric indicators.

⁴ See the comprehensive listing of documents describing assessments undertaken by ECLAC since the early 1970s, included in the last section of the present Handbook.

II. CONTENTS

This new version of the ECLAC Handbook describes the methods required to assess the social, economic and environmental effects of disasters, breaking them down into direct damages and indirect losses and into overall and macroeconomic effects. The Handbook is not aimed at identifying the origins of disasters or defining the actions to be undertaken during the emergency or humanitarian assistance stage, since these tasks fall within the jurisdiction of other institutions and bodies. Although this second version of the Handbook contains significant improvements, it is not a finished product. Rather, we view it as a work in progress to be enriched continuously by the experience and contributions of its users as they apply it to the unique challenges of each new disaster.

The Handbook focuses on the conceptual and methodological aspects of measuring or estimating the damage caused by disasters to capital stocks and losses in the production flows of goods and services, as well as any temporary effects on the main macroeconomic variables. This new edition also contemplates both damage to and effects on living conditions, economic performance and the environment.

The Handbook describes a tool that enables one to identify and quantify disaster damages by means of a uniform and consistent methodology that has been tested and proven over three decades. It also provides the means to identify the most affected social, economic and environmental sectors and geographic regions, and therefore those that require priority attention in reconstruction. The degree of detail of damage and loss assessment that can be achieved by applying the Handbook will, however, depend on the availability of quantitative information in the country or region affected. The methodology presented here allows for the quantification of the damage caused by any kind of disaster, whether man-made or natural, whether slowly evolving or sudden. The application of the methodology also enables one to estimate whether there is sufficient domestic capacity for dealing with reconstruction tasks, or if international cooperation is required.

ix

Although this Handbook provides methods for evaluating different types of situations, it is not intended to be all encompassing. However, the concepts and examples provided will afford the analyst the basic tools needed to examine cases not explicitly covered in this text.

The Handbook is divided into five sections. The first describes the general conceptual and methodological framework. The second section outlines the methods for estimating damage and losses to social sectors, with separate chapters on housing and human settlements, education and culture, and health. The third section concentrates on services and physical infrastructure, including chapters on transport and communications; energy; and water and sanitation.

The fourth section covers damages and losses to productive sectors, with separate chapters on agriculture and fisheries, industry, trade and tourism. The fifth section deals with overall, cross-sectoral and macroeconomic effects, with separate chapters on environmental damages, the differential effect of the disaster on women, the impact on employment and income, a damage overview that provides a procedure for calculating total direct and indirect losses, and the effects of the disaster on the main macroeconomic aggregates.

The damage overview is specially relevant since expressing total damage in comparison to the size of the economy or other general variables allows one to determine the magnitude of the disaster and its overall impact. The analysis of the effects of the disaster on the possible performance of the main macroeconomic variables or indicators should be undertaken for a time-frame ranging from one to two years after the event, although this may be extended for up to five years depending on the magnitude of the damage.

x In addition to the conceptual framework described in each chapter, practical examples of actual cases analyzed by the ECLAC Secretariat are included as appendices for each sector. To the fullest possible extent, these examples have been chosen in order to reflect a wide range of possibilities: different natural phenomena (climatic or geological in origin, sudden or slow evolving events), as well as the composition and relative weight of losses. We have cited geographically diverse countries, and special conditions of vulnerability such as those found in Small Island Developing States (SIDS). In addition, we have included recurrent or seasonal events and phenomena with varying occurrence cycles.

The Handbook is presented in such a form that specialists involved in evaluating specific sectors can quickly refer to relevant conceptual material and chapters that are focused on their specific field of interest. An electronic version of the Handbook is also available on CD-ROM or at the ECLAC website; it also includes examples of recent case assessments using the revised methodology. We hope that this second version of the Handbook will not only be more complete but also more "user-friendly" than the original.

We further hope that readers and users of the Handbook will contribute their experiences in order to enrich and improve future editions. It will be used as a tool to train technical personnel in the countries at risk and also as a means to increase a greater culture of prevention within the region.

III. THE BEST TIME TO UNDERTAKE THE ASSESSMENT

It is impossible to decide a priori the most opportune time to undertake an assessment, as it will depend on the type of phenomenon causing the disaster, its magnitude and its geographic scope. In general, experience shows that the assessment should not begin until the humanitarian assistance stage is completed or well underway, so as not to interfere with search and rescue activities and to ensure the availability of sufficient quantitative information on direct, indirect and macroeconomic damage and losses. Given that in each case the assessment team will require the assistance of numerous national and regional counterparts from the affected areas, assessment work must be scheduled to begin when such personnel are no longer involved in humanitarian assistance efforts or, as is often the case, they or their families are no longer considered part of the affected population.

On the other hand, the assessment should not be unnecessarily delayed as there is an urgent need to elicit support from the international community, whose attention may quickly be diverted by disasters in other parts of the world.

The timing or sequence of dealing with the subjects in each assessment cannot be defined beforehand because it will depend on the type and magnitude of the event. However, in general terms, the analysis should usually begin with an evaluation of the population affected by the disaster with an eye toward defining the different degrees of impact; one should also keep in mind the differential impact on men and women and their differing roles during the emergency, rehabilitation and reconstruction stages. As a second step, one can identify and analyze damage to the social sectors (housing and human settlements, education and culture, and health), highlighting the situation of the most vulnerable groups. Third, the economic sectors (agriculture and fishing, trade and industry, and services) and infrastructure may be approached. The analysis of the effects of the disaster on environmental assets and services can be undertaken concurrently.

The breakdown and depth with which the analysis is performed –as can be seen from the recent documents prepared by the ECLAC Secretariat– depend on the type of phenomenon involved and the availability of information for estimating damages and losses. In some cases it is possible to estimate damage and losses in minute detail, down to the level of vulnerable groups, municipalities or local communities.

IV. ACKNOWLEDGEMENTS

The Government of Italy, which made possible the 1991 publication of the first version of the Handbook, provided financial support for the preparation of this second edition. Further support was provided by the Government of the Netherlands through its technical program with ECLAC.

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The World Bank and the Inter-American Development Bank (IDB) were closely involved during the development of the revised version of the manual, participating at meetings to review progress and making valuable comments in various instances. The World Bank also provided input and financial support for the revision of this Handbook. Additional funding for this effort was provided under the umbrella of the ProVention Consortium, with the support of the Government of the Kingdom of Norway's Royal Ministry of Foreign Affairs and the United Kingdom's Department for International Development through its Conflict and Humanitarian Affairs Department.

xii ECLAC is deeply grateful for these contributions and also acknowledges the great importance to this exercise of interaction with many officials, academics and others who, in the course of assessment missions in the region, contributed ideas that enriched this manual.

V. AUTHORS

ECLAC entrusted the preparation of this version of this Handbook to Ricardo Zapata Martí, the Mexico City subregional headquarters official who acts as focal point for the subject of disasters at the Commission. Roberto Jovel, who directed the preparation of the first version of the Handbook, was hired as an external consultant to guide and supervise this version, as well as to write some sections. The following people, including members of the permanent staff, participants and in an interdivisional cooperation effort, and external consultants, were responsible for writing specific chapters:

Affected population: José Miguel Guzmán, with the support of the Latin American Demographics Center (CELADE), Alejandra Silva, Serge Poulard and Roberto Jovel.

Education and culture: Teresa Guevara, consultant from the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Health: Marcel Clodion, consultant from the Pan-American Health Organization (PAHO/WHO) and Claudio Osorio (PAHO/WHO).

Housing and human settlements: Daniela Simioni, ECLAC Division of the Environment and Human Settlements (DEHS); with support from Mauricio Faciolince, Ricardo Bascuñán and Silvio Griguolo (consultants).

xiii

Energy: Roberto Jovel, on the basis of previous work by Ricardo Arosemena (consultant).

Water and sanitation: Claudio Osorio (PAHO/WHO).

Transport and communications: Ian Thompson, head of the Transport Unit of the ECLAC Division of Natural Resources and Infrastructure, with a contribution by David Smith (consultant).

Agriculture and fishing: Antonio Tapia (consultant), with support from Roberto Jovel.

Industry and commerce: Daniel Bitran, consultant and official from the Mexican National Disaster Prevention Center (CENAPRED).

Tourism: Françoise Carner (consultant), José Javier Gómez (DEHS) and Erik Blommestein, ECLAC subregional headquarters for the Caribbean.

Environment: José Javier Gómez (DEHS), Erik Blommestein, Roberto Jovel, Alfonso Mata and Cesare Dosi, with contributions by David Smith, Leonard Nurse and Ivor Jackson (consultants).

Impact on women: Roberto Jovel, on the basis of a report by Angeles Arenas (consultant); with contributions by Asha Kambon and Roberta Clarke of the ECLAC subregional headquarters for the Caribbean, as well as from Sarah Bradshaw and Fredericka Deare (consultants).

Damage Overview: Roberto Jovel; and

Macroeconomic effects: Ricardo Zapata and René Hernández, from the ECLAC subregional headquarters in Mexico City.

The following ECLAC officials read the original manuscript and provided valuable suggestions that enabled the improvement of the final version of the Handbook:

Nieves Rico, Women and Development Unit at ECLAC headquarters;
Pilar Vidal, Women and Development Unit at ECLAC/Mexico; Esteban Pérez, ECLAC subregional office for the Caribbean.



Section One

Methodological and conceptual aspects

I. TYPES OF DISASTER AND POST-DISASTER STAGES

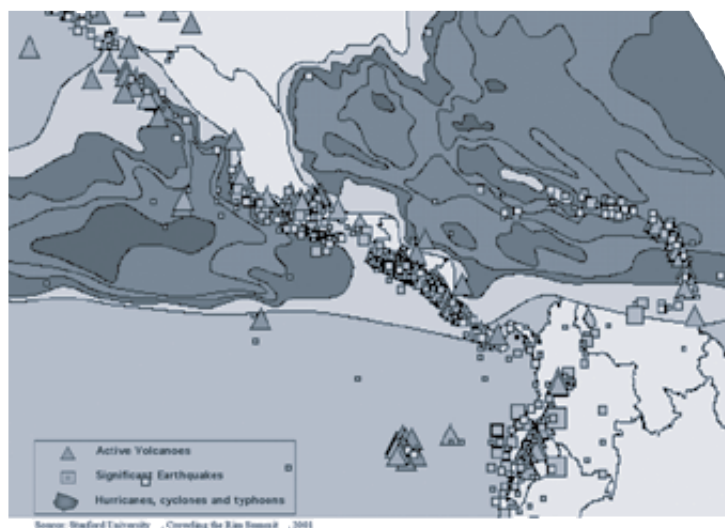
Disasters can be classified in many different ways. They are usually sudden and unexpected events –often accompanied by a loss of human life– that inflict on all or part of society suffering and harm, a temporary breakdown of existing vital systems, material losses and considerable obstacles to social and economic activities. Slowly evolving disasters, which tend to manifest themselves with fairly frequently, also affect societies and economies and, depending on their intensity and duration, can even cause food shortages or the inadequate provisioning of essential services.

Depending on their origin, disasters can be classified in two major groups: those deriving from natural hazards and those brought about by human activity. In addition, the effects of natural disasters are often magnified or exacerbated by prior human intervention. The most common natural disasters in Latin America and the Caribbean are those caused by tropical storms and hurricanes, floods, droughts, frosts and hailstorms, earthquakes, volcanic eruptions, tsunamis and mudslides. The most frequent man-made disasters are fires, explosions and oil spills. Some human actions increasingly cause or aggravate natural phenomena by failing to properly use natural resources or comply with codes and standards for the design and construction of development works. In other words, human intervention may increase the vulnerability of human settlements, production activities, infrastructure and services.

1

Natural hazards that cause disasters in Latin America and the Caribbean can be hydro-meteorological or geological in origin. Every year tropical storms and hurricanes move through both the Caribbean and in the tropical belt of the Pacific Ocean. The atmospheric and oceanographic modifications in the Pacific known as the El Niño phenomenon or the El Niño Southern Oscillation induce changes in seawater and cause floods and droughts. In addition, the presence of the "ring of fire" along the continent's Pacific coast, as well as various lines or areas of contact between tectonic plates, lead to earthquakes and volcanic eruptions.¹ The following graph indicates the areas most at risk of seismic, hydro-meteorological and volcanic activity including parts of the Pacific Rim and the Caribbean.

¹ Jovel, Roberto, "Natural Disasters and their Socioeconomic Effects", *ECLAC Review*, No. 38, ECLAC, Santiago, Chile, 1989.



2

A SYSTEMIC SYNTHESIS OF THE RELATIONS BETWEEN VULNERABILITY, HAZARD, EXPOSURE AND IMPACT, AIMED AT POLICY IDENTIFICATION

By Gilberto C. Gallopin

A review of the existing literature reveals that there is no consensus on the concept of vulnerability. A systemic approach is proposed here that includes the central elements of the debate (see for example, Clark et al., 2000; IHDP Update, 2001; Rodríguez, 2000), while giving them a systemic framework that raises new questions and lines of attack.

The vulnerability of a system is defined here, in the most general terms, as its propensity to undergo significant transformations as a result of its interaction with external or internal processes. Significant transformation is understood here to mean structural or, at least, relatively permanent and profound change.

The concept of vulnerability is not exclusive to social systems. In fact, it can be applied to any system that interacts with its environment, in particular human systems (e.g., a village, a social group), natural systems (e.g., a forest ecosystem) and socio-ecological systems including human and biophysical components (Gallopin et al., 1989).

Both societal and ecological systems survive thanks to the constant exchange of matter, energy and information with their external environment. Those processes can give rise to modifications in the functioning or structure of the system triggered by changes in the system's environment (e.g., the effects of an earthquake on a population), by internal alterations (e.g., the impact of civil war on a country) or the interaction among external and internal processes (e.g., the effects of a prolonged drought in a country with internal conflicts).

Whether the event/change/hazard is described as external or internal depends on the scale of definition of the system. Earthquakes and hurricanes are clearly internal phenomena for the planetary ecosystem, but they are obviously external events if the system in question is a Central American village.

In human systems, vulnerability is often related to (but is not the same as) poverty or an integrated measure of well-being. Not all poor people are vulnerable and not all non-poor people are invulnerable.

Vulnerability as propensity (Popper, 1990) is not an absolute property, but one relative to a system in a given context, including specific changes or hazards. In other words, a system can be vulnerable to certain disturbances and strong in the face of others. However, some systems might be so fragile that they exhibit "generic vulnerability" to many types of disturbances.

According to this general conception, vulnerability is not always a negative property. It is possible to speak of positive vulnerability in cases where change leads to a beneficial transformation such as the emergence of a given social group from chronic poverty or the collapse of an oppressive regime. Of course, characterizing transformation as positive or negative is inherently a value judgment. In this sense, the "significant transformations" that are part of the definition of vulnerability can be differentiated as positive or negative as in Table 1, which also differentiates how gradual or sudden they are.

Table 1
A classification of systemic transformations or impacts

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	*****	*****	*****	*****	*****	*****
Effects on the Environment						
Effects	Air pollution		Water pollution		Land pollution	

However, for the purposes of this manual, hereinafter we will limit the discussion of vulnerability to its negative aspects, and limit the phrase "significant transformations" to the particular case of "damage" or "adverse effects".

Central to the consideration of vulnerability are the concepts of the system in question's sensitivity and response capacity (target system, unit exposed or system of reference), the probability of occurrence, the type and magnitude/intensity/speed of the triggering event, exposure of the system to the event (external or internal) and the transformations or impacts the system undergoes.

Sensitivity is the degree to which the system is modified or affected by an internal or external disturbance or set of disturbances. Conceptually, it could be measured as the degree of transformation of the system per unit of change in the disturbance (Tomovic, 1963), but sometimes it only specifies whether the system is sensitive to a given factor.

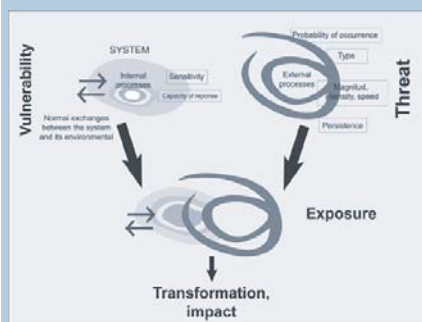
The response capacity is the system's ability to adjust to or resist the disturbance, moderate potential damage and take advantage of opportunities. Various factors play a part in determining response capacity, including resilience, the availability of reserves and information, internal regulation mechanisms and the existence of cooperative links with other systems.

The system's exposure to the disturbance, external or internal change, or hazard is the degree, duration and/or extension of the system in question's contact with the disturbance.

Vulnerability, as understood here, is a system attribute existing prior to the disturbance/change/hazard, although it is often related to the history of disturbances to which the system was exposed in the past (hence the importance of the system's history).

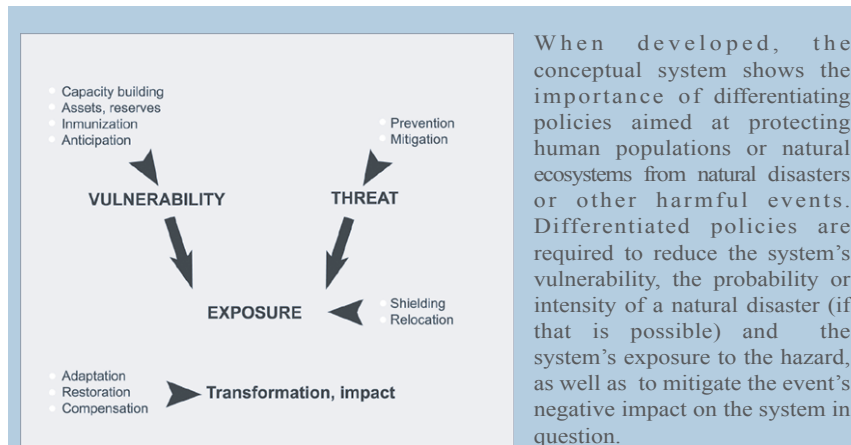
The system's exposure to the disturbance is, however, an attribute of the relationship between the system and the disturbance. As such, it is not an attribute of the system, but note that some authors include exposure as part of the definition of vulnerability (Cutter, 2001).

The impact on the system depends, apart from its vulnerability and exposure, on the event or set of events/changes/hazards, on the type of event (e.g., hurricane, earthquake, economic crash, internal conflict), its probability of occurrence, magnitude, intensity, speed (or gradualness) and persistence.



The difference between sensitivity, response capacity and exposure can be illustrated with a simple example such as a flood's effects on a population. The most precarious homes are harder hit by a flood than more solid ones (sensitivity). Oftentimes, the poorest homes are located in the places most susceptible to flooding (exposure). The families with the greatest resources have a greater availability of means to repair water damage (response capacity). The magnitude of the final impact will also depend on the intensity, magnitude and permanence of the flood (attributes of the event).

The figure above, illustrates the relations between the concepts discussed for the case of an event/change/hazard whose origin is external to the system. A similar diagram could be made for the case of the system's internal disturbances.



The next figure illustrates the type of policies most commonly associated with the different aspects mentioned.

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Tomovic, R. (1963), *Sensitivity Analysis of Dynamic Systems*, McGraw-Hill, New York.

After a disaster occurs, activities are normally grouped together into three different stages: a) emergency, b) rehabilitation and recovery (also called transition), and c) reconstruction.

The emergency stage refers to the period for humanitarian assistance, when steps are taken to save lives and to provide essential supplies to those most affected. It includes such activities as search, rescue, evacuation, provision of shelters, first aid, emergency medical care and protection, temporary restoration of transportation and communication routes, preliminary repairs to essential public services, and initial actions to register victims and record damage to public and private property. This stage may vary in its duration, but it is generally relatively brief, depending on the magnitude of the disaster.

The rehabilitation or transition stage includes activities required to restore normality to the affected areas and communities. It includes temporary repairs to housing and buildings and to transport and public utility infrastructure. Problems related to the emotional and psychological recovery of the inhabitants of the affected regions are also addressed during this phase. The recovery measures most helpful to affected communities are those that allow victims to return to work, help create new jobs, make loans and other financial resources available and launch projects related to other disaster consequences.

Finally, the reconstruction stage includes activities designed to rearrange the affected physical space and environment and enable the allocation of resources in accordance with the new social priorities arising from the effects of the disaster.

- 6 Assessment activities described in this Handbook should be carried out when the emergency stage has been completed or is nearing conclusion, so as not to interfere with those actions and to ensure the availability of the necessary personnel and basic information. They are intended to facilitate the identification of needs and priorities for the reconstruction stage.

II. GENERAL METHODOLOGICAL CONSIDERATIONS

The ultimate goal of the assessment methodology presented herein is to measure in monetary terms the impact of disasters on the society, economy and environment of the affected country or region. National accounts are used as a means of valuation, supplemented with procedures for specific estimates such as environmental damages and the differential impact on women.

Application of this methodology provides affected countries or regions with the means to determine the value of lost assets and define reconstruction requirements. It enables the identification of the most affected geographical areas and sectors, together with corresponding reconstruction priorities. In addition, it provides a way to estimate effects on economic flows, the affected country's capacity to undertake reconstruction on its own and the extent to which international financial and technical cooperation are needed. Moreover, it can be used to identify the changes to public policy and development programmes/plans needed to deal with needs arising from the disaster and to avoid undesirable effects in economic performance and public well-being.

It will often be necessary to conduct assessment work quickly in order to guide reconstruction activities and international support. The affected population's pressing needs must be met quickly, and it is essential to exhaust all opportunities to obtain reconstruction assistance before international attention is diverted to other areas of the world. Therefore, the timely presentation of the assessment takes precedence over exhaustive analytical precision, but this initial evaluation must clearly state the magnitude of damage and reconstruction requirements.

The following chapters offer a detailed description of the methodology and sources of information we recommend for the analysis of each sector, as well as those related to the assessment of overall impact. We also describe select criteria that are universally valid for addressing these questions.

The assessment should begin by gathering all existing quantitative background information needed for an appreciation of both conditions before the disaster and the magnitude of damage and losses and their macroeconomic effects. Assessors should consult government sources and industrial or professional associations (such as societies of engineers or architects), service providers, chambers of commerce and industry and farmer associations, as well as resident experts from national and international institutions or bilateral missions who may be in the affected country at the time of the disaster.

The reliability of the information obtained should be verified in the field. Sampling should often be used to determine both the number of units affected and the magnitude or extent of damage, applying appropriate assessment criteria in each case. The latter is especially true when determining the differential effects of disasters on women.

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The assessments for which this manual is designed are a basic tool in the decision-making process of defining and assigning priorities for reconstruction plans and programmes. As suggested earlier, proper consideration must be given to the balance between estimate precision and the urgency of completing an assessment in order to launch programmes. Assessment results must, at a very minimum, provide an accurate estimate of the disaster's impact, including its geographic and sectoral scope. More precise calculations can be provided later as specific investment projects are formulated.

SHADOW PRICES AND DISASTER DAMAGE ASSESSMENT

In terms of economic impact, a disaster may be considered the opposite of an investment project. Projects, whose results often take a physical form, involve decisions regarding the use of resources with a view to increasing, maintaining or improving the production of goods or the provision of services. The three basic parameters of an investment project are the amount of the initial investment, the lifetime of the project and the flow of costs and benefits generated by the project over its lifetime. From an economic standpoint, project viability is assessed by comparing costs to benefits.

In contrast, disasters cause damage to assets (they could be regarded as "disinvestments") and affect the production of goods and services, in terms of both their availability and the efficiency of production. If the method of project assessment is applied to specific economic sectors, three parameters are needed to assess the economic damage: (I) the amount of asset losses (or disinvestments); (II) the impact, in terms of prices and quantities, on the flow of goods and services in the relevant sector; and (III) the period in which markets are disrupted.

Like the methods for project assessment, the process of identifying the damage caused by a disaster involves comparing the "non-disaster situation" and the "disaster situation", rather than the "pre-" and "post-" disaster situations.² Otherwise, the damage caused by a disaster may be overestimated (in the case of production that was already tending to decline) or underestimated (if production was increasing), or damage may be attributed solely to the disaster when it may be due to other factors, as well.

There are two types of project assessment: private and social. In private assessment, annual returns derive from the sale of products or services, and costs derive from the purchase of inputs and factor payments. In social assessment, annual social benefits are obtained from the increase in national income generated by a project, while the costs refer to the income sacrificed by implementing that particular project rather than another one. Private investments may have social profit levels that are very different from the profits obtained by private investors themselves.

Social and private assessment use similar criteria to study project feasibility, but differ in their valuation of the variables determining the associated costs and benefits. Private assessment works with market prices, whereas social assessment uses "shadow", or social, prices. The latter take into account the indirect effects and externalities that affect the well being of society.³

² With regard to assets, the "pre-disaster" and the "non-disaster" situation are the same when the disaster takes the form of an event of short duration (hurricanes, floods, earthquakes); there may be differences in the case of slowly evolving disasters (such as droughts). Economic assessment of changes in the flow of goods and services, however, requires the projection of a "non-disaster situation" in order to compare it to a "disaster situation" so that the damage will be correctly attributed to the disasters (the case of tourism in Belize is a good example).

³ Some types of projects have private prices that are very different from their social prices: (I) those which generate public goods, where the private price is equivalent to zero; (II) those implemented where there are market imperfections (monopoly, monopsony); (III) those implemented where there are taxes, subsidies or quotas that make the prices of products and inputs different from what they would have been in a situation of perfect competition; and (IV) those implemented where there are externalities.

Social assessment uses the three basic shadow prices: foreign currency, manpower and the social discount rate. The social prices of the goods and services generated by the project also have to be calculated, as well as those of the inputs used in production. The three basic shadow prices are generally calculated at the national level. The shadow prices of the goods or services produced and of production inputs are calculated with information on current and future supply and demand; this requires specific studies that may be rather complex.

In theory, the methodology for the social assessment of projects may be adapted to the assessment of economic damage caused by disasters, and shadow prices may be used to obtain a close approximation of the value of damage to society. For example, the damage caused by reduced production of an export item that generates foreign currency for the country may vary greatly depending on whether it is assessed using private prices or shadow prices. Although this approximation might be preferable in theory, the use of private prices is more practical given the amount of information that social assessments require, the number of sectors involved and the short time usually available for damage assessment.

III. CLASSIFICATION AND DEFINITION OF DAMAGE AND EFFECTS

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Natural phenomena such as earthquakes, storms and floods not only produce immediately apparent effects, but they also unleash aftereffects that evolve slowly or emerge a relatively long time after the disaster has occurred, such as crop destruction due to the emergence of pests related to the event, or the shortage of essential products several months after the actual disaster.

This Handbook describes a proposed classification of a disaster's damages and effects that requires the application of two criteria: the methodology applied must provide an assessment of the full socio-economic and environmental effects at the time the disaster occurs as well as during its aftermath, and it must be able to do so at different geographical levels and sectors.

Granting that all definitions are by their nature conventional and that some cases may straddle the border between two concepts, the definitions applied here derive from the consensus achieved during the three decades in which such assessment activities have been undertaken in the region.

Expressed in the simplest terms, a disaster affects assets (direct damages); the flow for the production of goods and services (indirect losses); and the performance of the main macroeconomic aggregates of the affected country (macroeconomic effects). For convenience, use is made of the term damage or loss; however, disasters may also have a positive result. The assessment is therefore aimed at determining the net effect, giving due consideration to both negative and positive results.

Direct damages occur at the moment of the disaster or within the first few hours. Depending on the magnitude of the disaster, the latter two types of losses can extend over a period of up to five years. During slowly evolving or long-duration events –such as droughts or the effects of El Niño– direct damages may occur over an extended period and recur several times if the affected infrastructure was initially repaired and subsequently damaged anew, as in the case of bridges destroyed by repeated flooding. However, most losses will be indirect owing to the impact on economic flows.

During a quick assessment, identification and evaluation of direct damage is a relatively straightforward matter. The same cannot be said of a disaster's indirect effects. These indirect losses will become apparent at different times after the disaster and are, therefore, more difficult to identify during a rapid assessment.⁴

In fact, most of these indirect effects are not evident when the assessment is carried out, and although they can be identified when the damage is estimated, it is not always possible to measure them in monetary terms. In this respect, indirect effects in cases of slowly evolving disasters (such as droughts or extended flooding) will occur for as long as the causing phenomenon lasts.

10 The first two types of effects (direct damages and indirect losses) can be added together to obtain an order of magnitude of the total amount of damage, provided that it is duly indicated that the summation includes both assets and economic flows. The macroeconomic effects represent a different view of the assessment, however, since they describe the effects of the disaster on the functioning of the economy and the resulting macroeconomic imbalances arising from the event. Therefore, macroeconomic effects cannot be added to the other two categories of damages because that would involve double accounting.

Physical units (number of damaged or destroyed units, square meters of construction, hectares, tons, and so forth) are the starting point for any damage estimate. Using them will permit the adoption of the most suitable valuation criteria in each special case. Let us now turn to a detailed description of the damage to be estimated under each category of effects.

1. Direct damages

Direct damages (complete or partial destruction) may be inflicted on immovable assets and on stock (including final goods, goods in process, raw materials, materials and spare parts).⁵ In essence, this category consists of damage to assets that occurred right at the time of the actual disaster.

⁴ The time period to be considered in estimating indirect losses is equal to that required to achieve "normalcy" or a situation equal to the one prevailing before the disaster.

⁵ Entrepreneurs or owners of companies normally also count as losses those to realizable assets, such as destroyed accounts receivable which, will not be collected. However, from a macroeconomic viewpoint, such losses should not be included as direct damage because if said collections did take place they would represent an inter-sectoral transfer of revenue and including them would involve double accounting.

The main items in this category include the total or partial destruction of physical infrastructure, buildings, installations, machinery, equipment, means of transportation and storage, furniture, damage to farmland, irrigation works, reservoirs and the like. In the special case of agriculture, the destruction of crops ready for harvest must also be valued and included as direct damage.

As will be seen in the sectoral chapters, a distinction should be made between public and private sector damage in order to determine where the weight of the reconstruction effort might fall.

The same is true in the case of repairs,⁶ totally destroyed structures, equipment and stock. During the quantification of direct damage, the imported component necessary to replace the damaged or destroyed asset must be estimated as well, since this will have an effect on the balance of payments and trade.

THE VALUE OF A LOST LIFE

Disasters often result in the loss of human life. Setting aside the suffering sustained by families and society in general, fatalities are a direct loss to the society in any country affected by a disaster. They are a loss of human assets. There are indirect ways to estimate a monetary value of such losses.

A possible approach to estimating these losses would involve calculating the future income –expressed in net present value– that the deceased would otherwise have generated assuming that each had fulfilled her or his normal life expectancy. By comparing the average age of those killed by a disaster against their life expectancy –giving due consideration to sex differentials– it is possible to estimate the time loss for the deceased. A rough estimate of human asset losses may be reached by combining the resulting number of person-years with the expected average income over the appropriate time span.

Such a procedure has its shortcomings, however. As is well known, per capita income varies from one country to another. Using it as a yardstick to ascertain human asset losses would suggest that a human life lost in a developing country would be worth less than a life in a more developed nation, even within the Latin America and Caribbean region. This is morally unacceptable.

An alternative way of assigning a value to the loss of life would be the adoption of the amount paid by insurance companies in cases of airline-related accidents, as set forth by the Warsaw convention of the International Civil Aviation Organization (ICAO). However, here again shortcomings arise since the relevant values may vary by region.

⁶ In practice, the sectoral specialist will often value repairs as a percentage of the replacement value of a partially destroyed asset. Although this approach is expeditious, it should be enhanced by including estimation techniques more in keeping with the current value of those repairs.

A further alternative would be to adopt the average compensation paid by insurance firms in the region for accidental deaths related to hazardous activities. This method, however, cannot be used because the amounts paid depend on the actual payment capacity of insured persons, which most certainly do not match that of the average victim in a given disaster; it is also skewed by the same bias in regard to per capita income.

Other ways to arrive at the value of human life are based on the amount that a person is willing to pay to avoid premature death. For this purpose, one can use valuation methods based on a worker's annual contribution—determined through actual surveys—in cases of hazardous activities. This type of approximation has the advantage of reflecting costs not exclusively related to losses in production, but it yields higher figures than the previously discussed alternative procedures. Furthermore, it does not eliminate the problem related to differences in per capita income.

In brief, while there exist methods that might be adopted for the purpose, the above limitations render impractical any attempt to estimate the value of human loss of life.

2. Indirect losses

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This effect refers essentially to the flows of goods and services—expressed in current values—that will not be produced or rendered over a time span that begins after the disaster and may extend throughout the rehabilitation and reconstruction periods. Convention calls for a maximum five-year time-frame although most losses occur during the first two. In any case, the estimate of these effects must be extended throughout the period required to achieve the partial or total recovery of the affected production capacity.

These indirect losses result from the direct damage to production capacity and social and economic infrastructure. Indirect losses also include disaster-induced increases in current outlays or costs in the provision of essential services, as well as diminished expected income in cases where these services cannot be provided under normal conditions or at all (which in turn will be reflected in macroeconomic effects). Examples of indirect effects are losses of future harvests due to flooding or prolonged droughts;⁷ losses in industrial production due to damage to factories or a resulting shortfall in access to raw materials; and greater transportation costs as the need for alternative routes or means of communication imply longer, more expensive, poorer-quality options. These are indirect losses for the sector in question and will also be considered as macroeconomic effects when the main economic aggregates are examined.

⁷ However, if the disaster destroys crops that are about to be harvested, this loss should be considered direct damage, as mentioned earlier and as will be explained in the chapter on agriculture in Section Two of this Handbook.

The assessment specialist must be aware that some indirect effects of a disaster might generate benefits to society, instead of damage, costs, harm or losses. Indeed, indirect effects sometimes produce major benefits that can be estimated and must be deducted from the total damage estimate.⁸

Disasters also produce some major indirect effects that may be difficult to identify and impossible to quantify. These effects lead to "intangible" damage (or benefits) such as human suffering, insecurity, a sense of pride or antipathy at the way in which authorities have faced the disaster's consequences, solidarity, altruistic participation, the impact on national security and many other similar factors that have an effect on well-being and the quality of life. The assessment specialist will not always have enough time to attempt to place a monetary value on these important effects of disasters. However, he or she must be aware that a comprehensive evaluation of the effects of a disaster must include an assessment or at least a global discussion of such intangible damage or benefits, since they considerably affect living conditions and standards.

Finally, some indirect effects of disasters can be given a monetary value but are very difficult to calculate owing to the limited time available for the assessment. This category of effects includes the estimate of lost opportunities due to the impact of the disaster on the structure and functioning of economic activities, distributive and redistributive effects, losses in human capital represented by victims and so forth.

In brief, disasters often include one or more of the following types of indirect losses, which can be measured in monetary terms:

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- i) Higher operational costs due to the destruction of physical infrastructure and inventories or losses to production and income. For example, losses in sales of perishable goods or those that could not be stored in time and thus went unsold; unexpected costs incurred in the replacement of lost records in the health care system (clinical files in health centers).
- ii) Diminished production or service provision due to the total or partial paralysis of activities. For example, damages due to the loss of a full school term; the costs of not being able to comply with export contracts.
- iii) Additional costs incurred due to the need to resort to alternative means of production or provision of essential services. For example, the greater costs arising out of the use of longer or low standard roads (detours) and the construction of emergency roads.
- iv) Greater costs due to budgetary reorientation or reassignment.

⁸ For example, once waters receded from widespread floods caused by the El Niño phenomenon in a South American country, a relatively large amount of coastal land that had previously been unsuitable for farming was temporarily made fertile. The owners cultivated this land, and the resulting harvest was deducted from the loss estimates as an indirect benefit.

v) Income reduction due to the non-provision or partial provision of services by public utilities (power and drinking water); reduction in personal income owing to loss of employment or being forced to work part-time.

vi) Costs incurred by all parties involved in attending to the affected population during the emergency stage.

vii) Additional costs for dealing with new situations arising from a disaster, such as the cost of health campaigns to prevent epidemics.

viii) Lost production or income due to linkage effects, similar to those that occur during a recession, which can be "forward" or "backward". For example, the destruction of a factory, reduces the economic activities of suppliers who have no alternative markets or of clients who have no other suppliers.

ix) The costs or benefits of external factors; namely any disaster repercussion or side effect whose costs (or benefits) are absorbed by third parties who are not direct victims (or beneficiaries) of the disaster. This concept is quite broad since it includes effects such as the benefit of training for emergency workers or brigades, some environmental pollution costs, greater traffic congestion and other similar repercussions of a disaster. The assessment specialist should only consider relevant external factors that significantly modify the estimate of the amount of damage.

- 14** Not all types of effects are mutually exclusive, and the assessment specialist should ensure that no double accounting takes places. For example, if effects are calculated on the production side, they must not be included again on the income side; if the effects of budgetary reassignment to deal with the rehabilitation stage are identified, the spending it financed must not be taken into account later as an indirect cost.

In light of the above difficulties, estimates of indirect losses should best be undertaken in close consultation with the respective authorities or experts. This co-operation is essential in cases such as estimating the time needed to reestablish services, lost production volumes, greater costs incurred in the provision of services and the corresponding reductions in income. An analysis must also be made of the operating results of public utilities so as to estimate their possible losses while rehabilitation is ongoing, as well as of the prices and yields of lost agricultural and industrial products. This Handbook provides step-by-step procedures for undertaking these estimates for each of the affected sectors.

The concepts outlined above are quite broad. We recommend that assessment specialists narrow their focus so as not to waste too much time in quantifications that do not yield applicable results, such as the intangible effects of the disaster on human production capacity, or the indirect effects resulting from how the emergency process was handled, or even certain drastic economic measures that might have been taken. The idea therefore, is, to measure only the most important indirect effects, which could also be called primary or first-round effects.

Adding the direct and indirect effects indicated so far will provide an estimate of the total losses caused by the disaster.

3. Macroeconomic effects

Macroeconomic effects reflect the manner in which the disaster modifies the performance of the main economic variables of the affected country, provided the proper national authorities make no adjustments. Since they reflect the repercussions of direct damages and indirect losses, they must not be added to those lists. Rather, macroeconomic effect estimates are a complementary way to assess direct damages and indirect losses from a different perspective. Quantification of macroeconomic effects is usually done for the national economy as a whole. Sectoral specialists must provide the macroeconomist with the information needed to achieve a comprehensive view of the impact on the main economic variables. While a country serves as the basic unit for this analysis, similar exercises can be conducted for disasters affecting smaller areas or regions –a province, state, department or municipality– provided that the necessary information is available.

A valid estimate of the macroeconomic effects of a disaster requires a reliable forecast of how each of the variables would have performed had the disaster not occurred. Such a projection serves as the baseline for ascertaining the degree to which the disaster disrupted results that would have been achieved otherwise and the extent to which the deterioration in the main variables has affected the country's ability to meet rehabilitation and reconstruction requirements and to define international cooperation requirements, especially of a financial nature.

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The most important macroeconomic effects of a disaster are those that have a bearing on growth in gross domestic product and in sectoral production; the current account balance (due to changes in the trade balance, tourism and services, as well as outflows to pay for imports and foreign services, etc.); indebtedness and monetary reserves; and public finances and gross investment. Depending on the disaster's characteristics, an estimate of the effects on price increases, employment and family income is often relevant, as are changes to sovereign debt ratings, liquidity and domestic interest rates.

Gross domestic product can be undermined by reductions in the output of affected sectors, and it can be increased by reconstruction. When production is impaired, exports may narrow and goods may have to be imported to satisfy domestic demand, thus eroding both the trade balance and the balance of payments. Public sector spending generally increases as a result of disbursements made during the emergency and rehabilitation stages or to subsidies granted to significantly affected population groups. Fiscal revenues might drop due to decreased tax collection resulting from diminished production and exports, or even from a decision to temporarily lift some taxes to relieve pressure on significantly affected sectors. The combination of the above situations could provoke or expand fiscal deficits.

At the same time, prices may rise in response to shortages brought about by special demands stemming from reconstruction or by speculation, thus fanning inflation. The level of international reserves or the country's ability to meet its foreign debt servicing commitments might also be compromised depending on how the country's economy was performing before the event or the magnitude and effects of the disaster.

Macroeconomic effects to be gauged also include any deterioration in the affected population's living conditions as a result of obstacles to supply sources, reductions in the availability of essential services and, especially, the loss of employment and the corresponding fall in income. Although an erosion of the quality of life cannot be expressed in monetary terms, the effect of a disaster on a population or the drop in income caused by the partial, temporary or total paralysis of activities can be quantified.

To assess and globally consolidate macroeconomic effects, sectoral specialists must calculate foreseeable losses in the production of goods or services for the period they estimate is needed to recoup farmland, production equipment or physical and social infrastructure. They must also obtain background information that will enable an assessment of the impacts on other macroeconomic variables that have been mentioned (employment, income, exports, imports, gross investment, tax collection, etc.). Each specialist must prepare background information on how the sector was expected to evolve before the disaster based on recent performance or in accordance with goals established in each sectoral plan that officials adopted before the disaster.

The magnitude of the disaster is important for defining the time-frame for which macroeconomic effects are to be estimated. Experience shows that a "reasonable" time is normally the remainder of the year in which the disaster occurs (short term) plus another one, two or, under exceptional circumstances, five years (medium term).

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It is important to keep in mind that the estimate of macroeconomic effects only shows what would happen should the authorities of the affected country or region not modify current public policies and programmes. Performance projection this provides these officials with a tool for reorienting policies and plans in light of post-disaster reconstruction needs.

Although this subject is addressed more broadly in the corresponding section of the Handbook, some general methodological aspects that are frequently used for estimating some of the most important macroeconomic aggregates are described below.

a) Gross domestic product. The macroeconomic specialist must estimate at constant prices disaster-induced losses in the production of goods and services for the recovery period, including the time needed to recoup lost capacity. Such projections require information from sectoral specialists, who must also define how the sector was expected to perform in the year the disaster occurred based on pre-disaster forecasts. This estimate is the basis for projecting losses to obtain the pre- and post-disaster results. The macroeconomic specialist should also take into account the possible positive effect on GDP of increased construction activity owing to reconstruction.

b) Gross investment. Losses in stock, computed as direct damage, will not be reflected in gross investment for the year because this involves the destruction of pre-existing assets. Depending on the availability of resources and the country's engineering and construction capacity, gross investment should increase the following year as asset restoration gets underway.

In the year of the disaster, this variable will reflect two types of effects: the suspension or deferral of development projects underway prior to the disaster, and losses of stock. The sectoral specialist should supply the macroeconomist with this data, together with a five-year estimate of the investment each sector will need for repairs.⁹

c) Balance of payments. The macroeconomic specialist must estimate the current account of the balance of payments for the year of the disaster on the basis of sectoral reports on the following: i) any decline in exports of goods and services as a result of losses that curtailed tourist activity, or impaired either the merchant fleet or the capacity of companies that export services, such as engineering firms.; ii) increased imports required for the two- to five-year recovery and reconstruction stage such as fuels, food (lost harvests), and building materials or equipment; iii) relief donations in cash or kind; iv) reinsurance payments from abroad; and v) any reductions in foreign debt servicing resulting from post-disaster agreements with creditors.

The balance -of- payments capital account must be estimated largely on the basis of the medium- and long-term external financing requirements of priority investment projects that will form part of the reconstruction process over, say, the five years following the event,¹⁰ and the foreign financial complement required in view of a possible deterioration of the current account balance.

d) Public finances. This is another of the macroeconomic aggregates that must be quantified because the budget approved for the year the disaster occurs (as well as those in succeeding years) will most probably undergo major changes. In this regard, it is necessary to analyze the following possible macroeconomic effects: i) any shortfall in government revenues owing to reduced income from public sector companies, or declining tax receipts due to decreased production of goods and services and an erosion of income and consumer spending; ii) increased current spending related to the emergency, especially humanitarian relief and the urgent repair or rehabilitation of damaged public services; and iii) the investment demands of the reconstruction stage. The macroeconomist will have to try to make sense of the potentially contradictory data obtained from diverse sources. Then he or she will prepare public finance deficit estimates for the reconstruction years in order to better anticipate public sector financial requirements.

e) Prices and inflation. Although it is not always feasible or justifiable to measure general inflation levels before and after the disaster, a "sectorally" informed overview is needed of how supply limitations –arising out of the destruction of crops, manufactured goods, sales channels, transportation routes, etc.– might affect the price of certain goods and services that would have to be supplied by alternative means.¹¹ The influence of these variables on general and relative prices must be estimated and included among macroeconomic effects.

⁹ Or whatever period the sectoral specialist and the macroeconomist deem most suitable for reconstruction.

¹⁰ See the previous note.

¹¹ Prices may decrease if the substitute good that is imported or otherwise obtained from a non-habitual source is obtained at a lower price.

f) **Employment.** Sectoral estimates must be made of the overall effects on employment deriving from the destruction of the production capacity of social infrastructure and new demands for personnel arising during the emergency and rehabilitation process.

Finally, the experience gained from assessments by national and international institutions over the last 30 years makes it possible to draw certain relationships between the type of disaster and the nature of its damage. The most important of these are as follows:¹²

- Disasters of hydro-meteorological origin –such as floods, hurricanes and droughts– generally affect a wider geographical area than disasters of geological origin;
- In areas with similar population density, the number of victims in geological natural disasters –such as earthquakes– will very probably be higher than in the case of hydro-meteorological events;
- The destruction of capital stock in physical and social infrastructure resulting from earthquakes is generally much greater than that caused by floods;
- Production and other indirect losses, on the other hand, will probably be much greater in the case of floods and droughts; and
- A phenomenon of geological origin that causes floods or mudslides normally causes much greater production and other indirect losses than do other kinds of geological disasters.

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The following general effects are common to all types of natural disasters:

- A variable number of victims;
- A significant reduction in the availability of housing, health and education facilities that expands pre-disaster deficits in developing countries;
- A temporary decrease in the income of the most disadvantaged social strata, and a corresponding increase in the already high rates of underemployment and joblessness;
- Temporary interruptions in water and sanitation, electricity, communications and transport services;
- Temporary shortages of food and raw materials for agricultural and industrial production;
- A tendency for small businesses and providers of personal services to be among the first to recover regardless of the amount of damage sustained;

¹² Jovel, Roberto, op. cit., 1989.

- In countries with predominantly dual structures, a greater severity and duration of the loss of employment in the modern sector than in traditional sectors and in the industrial sector as opposed to agriculture, commerce and services;
- A modification of the employment structure during the rehabilitation and reconstruction stages as construction of housing and public works increases;
- A reduction in the volume of exports and an increase in imports; and
- A trend toward public deficits because increased social spending and greater investment is normally accompanied by lower tax collections and fiscal revenues in general.

4. Damage valuation criteria

Objective and accurate criteria are needed to assess the impact of disaster damage and losses. A true assessment will provide the basis for defining rehabilitation and reconstruction programmes.

Assessment experience in the past 30 years reveals the importance of adopting more than one alternative for the monetary estimate or valuation of disaster damage and losses and the impact to the economy of the affected country or region. This is true because damage valuation criteria depends on how the results of the evaluation are to be used. Moreover, the diversity of the goods affected by a disaster (housing, roads and highways, transportation, pipelines, sewers, drinking water and electricity networks, crops and agricultural land, manufacturing enterprises, commercial and recreational centers, etc.) requires the use of many sources and information that are not always comparable.

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Consequently, criteria for the valuation of disaster damage and losses may vary over a range or variety of situations within the extreme situations that are described here in.

The depreciated value of lost assets (or "book value") might be used to evaluate disaster damages. This involves estimating the value of the lost or damaged asset in its pre-disaster condition, taking its age into account in order to arrive at the value of its remaining useful life. This valuation method would be suitable for fixed production assets and others that, while not necessarily used in production processes, are subject to depreciation and obsolescence.

In countries that still have high inflation rates, the book value is not representative of an asset or good's actual market value. In such cases, an attempt could be made to estimate its original value and adjust it for inflation from the year in which the good was acquired and the year in which it was destroyed. However, this process is complicated by the long-term changing trends in the physical characteristics of price index components. In this case, there would be no alternative but to use the replacement cost (with or without depreciation).

At the other end of the scale, damage valuation can involve an estimate of the lost asset's replacement cost that includes future disaster mitigation elements. In other words, the replacement cost of a lost asset would include not only certain technological advances (because of its age, it is unlikely that an identical product would still be on the market), but also features making it more resistant to the impact of future natural or man-made phenomena.

Other, intermediate valuation options exist. As stated above, their application depends on the needs of the analysis, the characteristics of the asset being valued, the availability of information at the time the valuation is made and, most importantly, the time the sectoral specialist has available to carry it out.

Thus, an intermediate position would involve valuing asset damage on the basis of its replacement cost with the same characteristics as its original design and without deducting the asset's depreciation over its useful life. This valuation would be useful in determining the financing needs of the state or the private sector to replace their destroyed or damaged assets.

Replacement costs should be determined with or without mitigation because they will provide the basis for the definition of the country's financial requirements and possible foreign credit needs for rehabilitation and reconstruction of production units or services affected during the disaster.

- 20** Regardless of the valuation option that is adopted, damage to assets should initially be quantified in physical units (number of pieces of machinery and production equipment as appropriate, square meters of construction destroyed, bridges, kilometers of highways by class, hectares of crops affected, tons of agricultural products lost, etc.). This will facilitate defining the most appropriate valuation criteria.

Concurrently, illustrative price lists must be available for different goods and services, such as the cost of a square meter of construction for housing of different characteristics, industrial facilities, steel bar and other construction materials, current prices of the main agricultural products, and so on. These can be derived from information generally available on the components of consumer, wholesale or producer price indices. It is often advisable to employ the prices of capital goods or construction materials used in investment projects the government might have in its portfolio or might have executed recently, since they carry updated prices and characteristics.

The assessment specialist will often have to adopt intermediate criteria, such as between the value of a square meter of construction for a destroyed marginal village and the type of permanent housing solution the government intends to provide for the victims (which will undoubtedly imply a qualitative upgrading of housing), or between the value of a destroyed textile machinery that was close to obsolescence and the cost of replacing the unit with a technically more advanced one. In all cases, the value used should be that of the equipment functionally closest to the equipment destroyed, and its cost or characteristics should fall within what can actually be found in the market and financed.

Indirect damage stemming from the interruption of the production or service flows over a given period must be valued at producer or market prices, as appropriate. In the case of production sectors, losses must be assessed at producer prices because they represent the value of what was not produced as a result of the disaster. In the case of interrupted service production (days or months of classes, the number of medical consultations, transportation costs increased due to detours, etc.) the most suitable approach (and perhaps the only feasible one) is to value services not generated as a result of the destruction of infrastructure, based on the prices or fares paid by the final consumer or end user.

Costs and prices must be considered in “real” terms (the use of production resources, goods and services). In other words, financing costs would not be brought into the damage assessment. Such costs refer to commissions, interests, discounts, insurance and reinsurance, subsidies, and all free forms of post-disaster financing, paid or free of cost, domestic or foreign. (Note that costs or prices in the real economy are considered paid in cash). Transfers within the economy are also excluded from the disaster’s costs (or benefits) because they are transactions that do not use resources or produce goods and services.

When calculating indirect effects –that is, the interruption or reduction in the production flows of goods and services– it is advisable to try to estimate them both with and without the disaster; in other words, to make a comparison between what outputs would have been obtained if there had been no disaster and what was actually produced with the effects of the disaster. However, it may not be feasible to apply this approach to most sectors when the goal is a rapid assessment of damage.

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Finally, calculations of direct and indirect damage and losses should be carried out in local currency. However, it is often useful to convert these figures to United States dollars for the purpose of comparison and better understanding by the international community. Prices should be expressed directly in foreign currency in the case of export products or goods that have to be imported from abroad.

5. Sources of information

Disasters commonly obstruct normal channels of information, especially if the capital city or other political and administrative centers of a country have been significantly hit. Many public agencies and services will be impaired as they struggle to work out of provisional or temporary locations after being forced to evacuate their regular offices. Officials and experts might be engaged in fieldwork or drafted onto special commissions coordinating rescue efforts, thereby blocking access to several normal sources of information.

Assessment specialists must quickly evaluate their possibly far-flung sources of information. For example, if the offices of the national statistics institute are temporarily closed, an analyst may have to turn to other specialized centers or institutes for demographic and population data. Background information on victims is best obtained from the ministries of health or the interior, while information on damage to schools can be found at the education ministry or an agency in charge of the construction of educational facilities. National women's organizations must be approached for relevant information, and so forth for each specific piece of information needed. Moreover, background information can often be found only at the disaster site rather than in the capital city.

In most cases, assessment specialists must conduct an independent estimate of damage or a technical review of the assessments already made by authorities or rescue agencies. Their time will be limited and they must act in the adverse conditions of a territory that is just emerging from an emergency. We now describe some of the information gathering techniques derived from ECLAC's experience to date.

a) Strategic sources

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Regardless of whether the emergency and rehabilitation organization is centralized or decentralized, the assessment specialist must locate a network of national organizations, national and international agencies, research centers and key people capable of providing the necessary data and authority to request and obtain additional documents and reports on the disaster. Despite the urgency of the situation, assessment specialists must only use documented facts, their own observations or those that can be derived from credible oral reports or summaries of the situation. In almost every case, without the support of such strategic sources, the assessment specialist will have no way of judging the validity and reliability of information or of harmonizing different opinions or contradictions.

b) The press

From day one, the press publishes news of the disaster that the assessment specialist may find useful. Newspaper clippings should be classified into easily manageable categories. The file must be kept up-to-date since it is of capital importance in four aspects of the assessment process: i) to locate names of potential strategic sources and useful documents; ii) to provide an independent opinion confirming the consistency and coherence of available official and unofficial information; iii) to draw attention to geographical areas and types of damage that may not have been covered by previous analyses; and iv) to provide data and figures that might complement the background information obtained from other sources.¹³

¹³ The assessment specialist must take due care to identify –and assign relative weight to– "sensationalist" information sometimes provided by the press.

c) Maps

Maps are an essential aid to the assessment specialist and must be obtained from the outset of the assessment mission. If they exist, post-disaster maps detailing the catastrophe's effects are particularly useful, but they are usually difficult to obtain as they are constantly being updated. It may be difficult to track down even basic maps from central institutions.

d) Reconnaissance missions

Such missions may be carried out by land, air or water. If, as is commonly the case, the assessment specialist can only conduct one reconnaissance mission, it should be undertaken after an initial desk assessment of information sources has been completed. This will help ensure that additional information not available from previously consulted sources can be collected during the field mission. In isolated or difficult to reach areas, the reconnaissance mission will often be the only possible way to gather information. This mission will provide the assessment specialist with the elements necessary to judge the quality of the information sources to be handled throughout the damage assessment process, and it also will make it easier to apply one's criteria in prioritizing disaster effects. Finally, such a mission is a unique opportunity to directly observe major damage that might not be included in any documented source.¹⁴

e) Surveys

Undertaking the detailed surveys needed for the rehabilitation and reconstruction stages, is only possible toward the end of the emergency phase, long after initial damage assessments are made. Three types of surveys can be very useful: i) studies carried out by offices and agencies that perform "rapid appraisal" surveys such as onsite inspection of the number and extent to which houses were damaged or destroyed, or local assessments of the number of victims and the morbidity structure; ii) broader studies that offer comparisons against pre-disaster conditions such as employment and unemployment surveys in the main cities (these tools are very useful in several stages of the damage assessment process and are analyzed below as an integral part of the secondary analysis of data); and iii) the rapid appraisal surveys the assessment specialist(s) can conduct, especially during reconnaissance missions (these should be viewed as a last resort whenever no better sources of information are available).

Surveys required to ascertain the differential effects on women pose a special challenge since there is no indirect way to obtain data on the increased workloads on productive work and on the assets and income losses in the backyard economy that women sustain in the wake of a disaster. A field survey of women temporarily living in shelters should be undertaken, whenever possible, to obtain such information.

¹⁴ This is often true in assessing damage to social sectors and the affected population, but it applies to all sectors. For example, while an initial assessment of an earthquake suggested that most of the damage was confined to the destruction of several kilometres of an oil pipeline, an air reconnaissance mission revealed major damage to agriculture due to landslides, something not initially taken into consideration.

f) Secondary data analysis

Publications, documents and reports containing background information prepared by secondary sources (institutions or persons other than the assessment specialists) can be fundamental sources of information. Regardless of the damage assessment methodology adopted, it will require a comparison of the post-disaster situation with a pre-disaster one. Secondary sources are the assessment specialist's best alternative when it comes to ascertaining pertinent values and the situation prior to the disaster. Moreover, pre-disaster background information will provide the starting point for an assessment of the disaster's effects. Without it, an objective damage assessment is impossible.

Reliable and valid data on the physical characteristics of the affected territory and its population (size, distribution, sex, age, density, economic, cultural and ethnic characteristics, etc.) must be obtained. When the assessment falls within the responsibility of government institutions or international organizations, the assessment specialist must use official sources or documents based on official sources to the fullest possible extent.

24 Population and housing censuses are particularly useful, as are sectoral censuses (agriculture, manufacturing, mining, etc.), statistical year books, statistics and census office reviews, any publications by research centers in the country affected and surveys carried out by official agencies, university centers or other authoritative bodies. In the immediate post-disaster stage, documents will be scarce and of the nature described above: partial surveys carried out by public offices and international agencies, together with internal reports by the institutions most closely involved in the emergency and rehabilitation stages.

g) Interpersonal communications

Assessment specialists often have friends or colleagues who are living within or near disaster areas. Contact with these reliable sources –by telephone, the Internet, radio or telegraph– is very useful for obtaining background information. Given that one of the first activities is to re-establish communications, it is highly likely that one of these systems will be working. Once contact is made, assessment specialists should make sure they clearly request specific information, which must then be verified by carefully comparing it against any independent sources that might be available.

h) Remote sensing data

Images obtained by means of remote sensors, especially those taken by satellites, can be extremely useful in damage assessment. However, their application faces certain important limitations.

First, there are obvious advantages to using satellite images for assessing the impact of phenomena such as floods, hurricanes, mudslides, earthquakes and volcanic eruptions, forest fires and oil spills. However, these images usually lack the resolution needed to identify physical damage to infrastructure. For example, from the air, a building may seem to be intact and yet have been earmarked for demolition because of internal structural damage. These sources cannot identify the injured or wounded, damage to sewers and underground pipelines, or internal damage to factories and commercial establishments.

These limitations may be overcome once a detailed geographic referencing system becomes available, but in the meantime, satellite images can be used to identify areas at risk in hazard mitigation and prevention work.

Second, acquiring images to be used in disaster assessment may be too expensive for most developing countries. Therefore, their use will likely be restricted to relatively more developed countries or to those cases where a developed country may decide to donate images to an affected country.

As we have previously noted, satellite-imaging techniques are a powerful tool in pre-disaster stages, especially in planning, early warning and vulnerability analysis. They can also be of obvious use during the reconstruction stage, when large amounts of satellite data can be rigorously classified and analyzed.

When available, aerial photography can be a powerful aid, but its importance can be overestimated. Experience shows that non-professional photography that is not systematically conducted will contain little information of use to the assessment specialist. However, the opposite is true when aerial photography is part of an aero-photogrammetric system, thus providing the assessment specialist with all the elements needed for a correct interpretation of the nature and magnitude of damage. When possible, therefore assessment specialists should make their estimates and calculations in close cooperation with personnel specialized in aero-photogrammetric analysis.

Section Two Social Sectors



Section Two of the Handbook refers to social sectors. It includes chapters describing methods for estimating the affected population, and damage to housing and human settlements, education and culture, and health. We begin by describing the evaluation methodology, offering practical examples to help the reader better understand and use the Handbook.

In Section Five of the Handbook, we discuss how to estimate effects on employment and income and the differential impact on women as part of comprehensive disaster analysis. Each chapter on individual sectors –whether social or economic– cites specific sources the specialist can use to obtain basic information needed for a complete, comprehensive analysis.

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I. AFFECTED POPULATION

The quantitative expression of the size and characteristics of the population affected by a disaster is a central part of the assessment process. One of the first tasks of the specialist in social themes is to work closely with the other sectoral specialists in the assessment group to define the geographical area that has been affected. Then one must estimate the affected population, including the number of victims, the situation of the displaced population and the site of possible reconstruction activities.

Estimating the affected population –the one item where all intangible factors come together– is essential for attaining an overview of the disaster and assessing the damage and losses in each sector such as agriculture, health and housing. This population evaluation provides an independent measure against which the consistency of the rest of the estimates can be gauged, and it constitutes the starting point from which to direct all national and international relief efforts and to set priorities for rehabilitation and reconstruction plans.

1. Definition of affected geographical area and population

Disaster assessment must begin with a definition of the affected area. The dimensions and characteristics of the affected population should be determined immediately thereafter. If possible, an assessment should be made of the post-disaster situation in order to obtain an overall idea of the intangible deterioration (or improvement) of conditions governing the standard of living. The population specialists will have to use their own analytical criteria in choosing among the wide array of conflicting means for defining and measuring the affected population. It is generally useful to begin with a broad view of the affected area and population and then narrow it down.

The data most often used for such estimates are available in the most recent population and housing censuses, as well as in population estimates and projections derived from these and other sources, which can be found in official or academic publications. These data can be complemented by information from household surveys or by vital or administrative records.

A single procedure should be used to define the extent of the affected area, an exercise that should be completed before the assessment process for each sector is begun. Affected population estimates provide a common and essential reference point for later achieving a more precise damage assessment for each sector.

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The strategy of choice for determining the affected population will depend on the kind of phenomenon that caused the disaster. (Examples of selection strategies are described in Appendix I.). Other factors influencing strategy choice include the availability of detailed and up-to-date census data or population projections; unforeseen demographic changes that might render such projections invalid; and the time elapsed since the most recent census. The greater the time elapsed since the last census, the greater the number of necessary estimate assumptions and uncertainties regarding the validity of the projections. The more the census data is disaggregated, the more likely the estimates will be correct. Because of the need for a rapid assessment, one can take at face value any very recent census data, especially if no important pre-disaster demographic events have occurred in the area since the census, such as significant migratory flows and the emergence of new settlement areas.

The following are possible approaches based on two alternative scenarios:

(1) Annual population projections at a detailed (e.g., municipal) level are available, the disaster has occurred no more than five years after the most recent census, and there have been no important demographic changes in the affected area since the most recent census. In this case, once the geographical area has been defined (identification of the affected municipalities), the projected population for the year can be taken directly, or it can be estimated for the date of the disaster using the following exponential growth formula:

$$P_d = P_o * e^{rt} \quad (1)$$

where:

- Pd = the population on the day of the disaster;
- Po = the most recent official estimate of the population;
- r = the annual exponential growth rate for the year or period in which the disaster occurs; and
- t = the length of time in years between the initial projection date used to calculate r and the time of the disaster.

Example: An assessment is made that a disaster that occurred on November 10, 2000, has affected 15 municipalities with a projected population of 3 590 000 on June 30, 2000 and 3 695 000 on June 30, 2001.

$$P_{10/11/2000} = P_{30/06/2000} * e^{rt}$$

The growth rate r can be calculated by applying formula (1):

$$r = [\ln (Pd/Po)]/t$$

$$r_{2000-2001} = [\ln(P_{30/06/2001} / P_{30/06/2000})] / 1$$

$$r_{2000-2001} = [\ln (3\,695\,000/3\,590\,000)] / 1$$

$$r_{2000-2001} = 0.02883$$

If

t = date of the disaster minus initial date of the population estimate

$$t = (\text{November 11, 2000} - \text{June 30, 2000})/365$$

$$t = (134)/365 = 0.36712$$

then,

$$P_{10/11/2000} = P_{30/06/2000} * e^{rt}$$

$$P_{10/11/2000} = 3\,590\,000 * e^{0.02883*0.36712}$$

$$P_{10/11/2000} = 3\,628\,199$$

When significant changes have occurred in any of the affected areas (significant emigration or immigration flows before the disaster and after the census, for example), appropriate adjustments to the projected population figures and new projected totals must be made before undertaking the estimate shown above. Adjustments can be made by following the procedures shown in case (2). Once the new adjusted totals for the population of the affected area have been calculated, the procedure shown in (1) should be followed.

(2) The disaster has occurred five or more years after the most recent census, and, therefore, the projections at a disaggregated level may not be updated or do not exist. In this case, once the geographical area has been defined, either a projection of the population should be done or the available estimates should be analyzed to determine whether there is any evidence of municipalities whose population has increased or declined to a greater degree than that observed in the preceding inter-census period.

If there is no disaggregate population projection or if the existing one is out of date, it will be necessary to make a projection of the population in the affected area.

It is possible that projected information is available for a larger geographical area. In this case, the population of the affected area should be projected by applying the growth rate for the population of the department, province or state in which the area is located for the year or period that includes the date of the disaster.

Example: An estimate is required for the population of the area affected by a disaster that included 20 districts of Province X on January 15, 2001. According to the census taken on June 30, 2000, the corrected population figure for the area is 1 536 000. According to the department's own projections, the population of Province X will grow at a rate of 1.89 percent in the 2000–2005 period.

In this case, the estimated population of the affected area on the day of the disaster is calculated as shown below:

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According to formula (1)

$$P_{15/01/2001} = P_{30/06/2000} * e^{0.0189*0.54110}$$

$$P_{15/01/2001} = 1\,536\,000 * e^{0.0189*0.54110}$$

$$P_{15/01/2001} = 1\,551\,789$$

In the previous example, it is assumed that no sudden demographic flows have occurred in the corresponding districts or municipalities, or that they were confined to displacement directly within the impact area. If this is not the case, it will be necessary to make separate projections for those municipalities or districts whose population growth or decline was greater than expected before continuing with the rest of the procedure. Additional sources of information (e.g., school rolls, new building permits and other administrative records) are necessary for such estimates, which involve specific methodologies.

The following two case studies demonstrate how to determine the affected geographical areas and population for two different disasters that occurred recently.

First case: In the case of an earthquake that occurred recently in a Central American country, there were conflicting versions as to the affected area and population. The population specialist made his or her own estimate by adopting the following procedure:

- To arrive at a broad initial estimate, the specialist marked on a map showing political and administrative divisions the geographical area where the population felt the earthquake, which registered V on the modified Mercalli intensity scale.
- The specialist then narrowed the area to include only those sections that reported victims or damage by reconciling official and unofficial partial data, figures obtained from an exhaustive study of press reports following the disaster and estimates gathered by visiting some of the affected areas.
- Some of the areas thus defined were virtually inaccessible, their population scattered or the latest census figures unreliable. The specialist then excluded those sections where only slight damage had been reported, and made "guesstimates" of damage in the remaining area (this was unavoidable given the limited time available to complete the assessment of damage).
- Census information was used as the basis for choosing the political-administrative unit with the most detailed population data. The area was thus defined, and the adjustments and projections needed to prepare a definitive estimate of the affected population were made.

Second case: In a similar case, where an earthquake affected a relatively inaccessible area of the Andes Mountains, it was necessary to determine the size and whereabouts of the population most affected by the disaster. The task was made more difficult because this was a rural area with a scattered population, and maps with current information about the population had not been located.

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The following procedure was adopted:

- Information needed to identify the small, scattered population nuclei with sufficient accuracy was obtained from the cartographic bureau.
- By using this and other information related to material losses and the number of people affected, the population specialist was able to estimate the damage and the affected population in the hamlets, villages, and towns that were accessible by land. Information provided by teams sent to inspect nearby places (mainly to check the reliability and validity of the figures) made it possible to determine what percentage of the population had been severely affected in those localities. Although it was not feasible to visit large areas nearer to the epicenter, observations made in settlements with a concentrated population provided rough but clear evidence that as one got further away from the epicenter, the damage tended to diminish.
- With the resulting population data in hand, the specialist drew two concentric circles around the epicenter. The radius of the inner circle was the distance between the epicenter and the severely affected population centers furthest from it. The radius of the outer circle extended to the furthest population center in which the earthquake had been felt. Since the construction features of rural housing were also known, it was possible to estimate the size and location of the most severely affected population in the inner circle. Estimates of the total affected population (both urban and rural) were made on the basis of the population located within the circumference of the outer circle.

2. Software for accessing pre-disaster population data

a. General comments

As noted in the preceding paragraphs, the specialist must first define the affected area before estimating the varying degrees of population affectation. It is relatively easy to estimate the primary affected population by using available information about the number of people that are dead, wounded and housed in temporary shelters. To estimate the size of the remainder of the affected population (secondary and tertiary levels), baseline data on the total population living in the affected area at the time of the disaster is needed.

Once the disaster area has been defined, the sectoral teams work separately to gather and analyze information. Reports of deaths, injuries and shelter occupancy are the first field data on the primary affected population to become available. The analyst must then make estimates to compensate for holes in existing data on the pre-disaster population; here baseline information is essential. Population censuses (even when they were made well before the disaster) and household surveys (even if presented at less disaggregated geographical levels) may be used for this purpose. Detailed population data is generally more readily available when the affected area is very large (such as an entire region or province), but less accessible for smaller areas. In these cases, researchers should make use of computer software that is able to process population data from censuses and household surveys. A number of such software alternatives exist.

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CELADE has developed and offers free of charge a programme called Redatam that can process population information from censuses and/or household surveys. Its ease of use and availability at no cost are advantages that cannot be overlooked. Furthermore, it has been tried and proven by ECLAC during several special assessment field missions.

Redatam G4 and its interface applications, such as R+G4xPlan, are designed to help generate population indicators from a variety of data sources. This facilitates decision-making at different geographical levels, from a country down to a municipality. The programme's features make it ideal for estimating the population and its characteristics in user-defined disaggregated areas, such as a set of districts added to another group of city blocks or rural sectors. Such a user-defined selection in combination with basic census or survey information can serve as a starting point for estimating the characteristics of the population and housing in these areas. These findings can be used to project population size. Alternatively, the increase in population up to the date of the disaster can be estimated using the methods mentioned earlier. This process is shown in Appendix III.

b. R+G4xPlan (pre-designed interfaces)

CELADE also makes available another Redatam-related tool. This is a Redatam interface known as RxPlan that makes it possible to use the database without needing to know how to use Redatam directly. This interface, which is very simple to create, can be generated before undertaking an assessment activity. It makes it possible to build modular applications tailored to the needs and specifications of the country and the disaster and to create predefined indicators (e.g., the number of households headed by women and the number headed by men; the number of unoccupied dwellings in comparison to occupied ones; the distribution of the affected population sorted by basic characteristics such as age, sex, marital status, education and employment) and to produce thematic maps.

Its interface consists of question forms or windows that produce output tables once a geographical area has been selected. It requires a census database in Redatam format and a map, if one is available.

This tool can assist in gathering information in a study of victims according to the optimum disaggregation level by considering the following items of information that should be obtained from data collected before and after the event:

- Total affected population (dead, wounded and those who have suffered material and economic loss);
- Disaggregation by age, sex and other basic characteristics; and
- Identification of high-risk categories (children under five, nursing mothers and pregnant women, the disabled or wounded and the aged).

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3. Estimating the affected population

Since the population may be affected in different ways and to various degrees depending on the source of the disaster and the resulting damage and losses, we can break it down into primary, secondary and tertiary categories.

We thus establish a link between the affected population and the type of direct or indirect damage sustained, which may consist of lost capital or production or an increase in the cost of providing services. This link allows for a classification of the affected population in accordance with the three main components of total damage mentioned above.

a. Primary affected population

This category includes people affected by the direct effects of the disaster and consists of the dead, the injured and the disabled (primary trauma victims), as well as those who suffer material losses as a direct and immediate consequence of the disaster. This segment is made up of people who were in the affected area at the time the disaster occurred.

b. Secondary and tertiary affected population

These two types of affected population are defined as those segments of the population that suffer a disaster's indirect effects. The difference between the two groups is that the secondary affected population is located within or near the boundaries of the affected area, while the tertiary affected population usually resides outside or far away from the affected area.

Estimates of damages and losses sustained by secondary and tertiary affected population will be given by the sectoral assessments. Examples of the secondary affected population are the merchants in the affected area and people traditionally involved in marketing the lost crops, both of whom lose income as a result of the recessionary post-disaster environment. Examples of the tertiary affected population include people who have to assume the higher transport costs generated in the affected area, although they themselves live and work outside of it, and those who lose some benefits because public expenditure is reallocated to priority emergency activities.

In slowly evolving disasters, such as droughts or floods, secondarily affected people often take refuge in institutional or informal shelters. It is useful to keep a separate record of such people since their presence may provide an early warning of significant internal migration flows.

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c. Assessing the direct and indirect effects on the population

Each sectoral assessment measures, in monetary terms, all direct damages and indirect losses sustained by the affected population. Damage to personal property is usually recorded in the housing sectors, while losses in production are included in the assessments of the productive sectors. Estimates of employment and income losses are made separately, as shown later in the Handbook.

The monetary loss due to deaths caused by a disaster may be high. From a methodological standpoint, it is possible to allocate a monetary value to such losses based on the victims' expected remaining period of useful life and the corresponding income that they would have earned, or based on life-insurance benefits. However, we do not engage in these estimates for two reasons. First, the purpose of this Handbook is to determine an amount of damage that can reflect the socio-economic impact of a disaster on the economic performance of an affected country or region. Second, using per capita earnings would result in the adoption of "second- or third-class" citizenship standards when comparing the victims with those in relatively more developed countries. In conclusion, loss of life is considered by ECLAC to be a permanent loss to society that cannot be substituted or recovered.

The most widely recognized effect on disaster victims is the deterioration in living standards. The physical environment is degraded, as are networks of social interaction whether they be on-the-job contact, communications systems, culture, and recreational activities; people begin to feel insecure and lose confidence in their way of life; access to education, health, and food is made more difficult; and the loss of homes and belongings reduces normal living standards.

Effects differ depending on the sex of the affected population: men generally sustain higher capital stock losses, while women usually end up facing increased reproductive workloads.

Other effects on the population –psychological harm and societal change, the solidarity or generosity shown in confronting the disaster, the despair of those who do not receive aid and many similar intangible costs or benefits– can only be estimated using indirect methods.

Disasters also produce psychological after-effects. Episodes of depression, anxiety, fatigue, nervousness, irritability, loss of appetite, modified sleep patterns and psychosomatic symptoms, such as diarrhea and headaches, have been observed and measured both during and after the emergency stage. Psychiatric interpretations of disaster effects suggest that damage of this nature may have significant short- and long-term effects. On the other hand, sociological research shows that while disasters produce significant stress, victims do not seem to behave in a dysfunctional way: profound pathologies are not common, psychological damage eventually disappears, and recovery is speedy.

The affected population's response mechanisms do not coincide with the alarmist version of events that dominates the media. Experience shows that victims tend to respond positively rather than panicking. Although cases of looting, plunder and social disruption have been observed in some cases, expressions of solidarity and support are the rule rather than the exception. Therefore, the population specialist should not try to estimate a probable cost for social disruption as a specific aspect of damage to victims.

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Few events reveal societal inequalities better than the destruction caused by a disaster, especially in developing countries. The devastation suffered by the poorest people is so disproportionate that it becomes obvious where the cause lies: one is vulnerable because one is poor. These population strata are disproportionately affected by environmental degradation and the depletion of natural resources that are the basis of their urban and rural livelihood. In addition, inequalities among men and women become more acute. It is not unusual, therefore, for disasters to be followed by sweeping societal changes. To an even greater degree than intangible effects and psychological damage, the effects that cause societal change defy precise identification and measurement when making a quick damage assessment.

4. Estimating demographic effects after a disaster

Direct and indirect demographic effects of disasters are apparent in the components of population growth (mortality, fertility and migration), increased morbidity rates and/or the aggregate effect on population growth itself.

Direct effects on mortality rates refer to deaths that were an immediate consequence of the disaster and are included in the fatalities report. However, there are indirect effects on mortality rates that lead to loss of life in the short or medium term. In the short term, deaths, both in temporary shelters and elsewhere, may occur as a consequence of the increase in morbidity (such as acute respiratory ailments and infectious or parasitic diseases) caused by the disaster.

The deterioration in living conditions stemming from the disaster may still be felt in the medium term as a result of increased vulnerability and the deterioration of health, housing and basic-service infrastructure in general. The effects of a disaster on mortality and morbidity rates are determined in the health chapter of this Handbook. It is worth mentioning that the assistance provided after a disaster may have an indirect positive effect on the mortality rate if it brings about changes in health policy that improve the coverage and quality of services.

To estimate the specific demographic impact on the mortality rate by age and on the average life of the population, it is necessary to determine the age and sex structure of direct fatalities (and indirect ones, if feasible). Estimated life expectancy is calculated with the aid of a life table. The same table is then used to obtain a different average life expectancy figure by adding the additional fatalities caused by the disaster to each age and sex group. The difference between both is the number of years lost as a result of the disaster.

It is not as easy to calculate the indirect effects on fertility. The postponement or cancellation of marriages and a temporary drop in the frequency of sexual relations after a large-scale disaster or one with a long-lasting impact might lead to a short-term decline in the fertility rate. But there might be an effect whereby it recovers in the long term, as has been observed in the case of wars or other great crises. Sudden disasters, such as earthquakes or hurricanes, have substantial effects on the fertility rate only if the primary affected population is significant, thereby reducing the number of women of fertile age.

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The link between cause and effect is very clear in the case of a disaster's impact on migration, but population specialists are likely to encounter difficulties in assessing the effects. Loss of property (land, homes, etc.) as a result of a disaster may lead to temporary population displacement. Other medium-term effects may be more significant. A change in production structure and in levels of employment may have a significant destabilizing effect. For many, this may create an opportunity to look for a new job or to emigrate, as was the case in the 1985 Mexico City earthquake. Since it is impossible to assess these impacts immediately after a disaster occurs, this analysis will have to be done later.

The full impact on demographic growth may be assessed only after the effects on the three previous components are known. Given the difficulties mentioned earlier in relation to fertility and migration, it will at least be possible to calculate a disaster's impact on demographic growth by taking loss of life into account. For example, if a disaster causes 200 deaths in an area whose population, in the year of the disaster, would normally have grown from 35 000 to 37 000 (that is an absolute growth of 2 000 people), it may be estimated that 10 percent (200/2 000) of the area's total growth failed to materialize as a result of the additional loss of life arising from the disaster.

Finally the effects on the elderly and the young must not be overlooked. These are especially vulnerable population groups that can be affected more intensively depending on the type or origin of any given disaster. A large impact on these groups may modify the prevailing demographic structure of the affected country, region or locality.

APPENDIX I

METHODOLOGIES FOR DETERMINING THE AFFECTED AREA
ACCORDING TO THE TYPE OF NATURAL PHENOMENON

A. Seismic phenomena

Events

- Fault-line movements
- Tremors and earthquakes
- Liquefaction
- Tsunamis

Effects

Partial and total destruction of homes; large number of dead and wounded, especially those suffering fractures, as well as people left disabled or orphaned; an extended

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	*****	*****	*****	*****	*****	*****

Effects on the Environment

Effects	Air pollution	Water pollution	Land pollution
		Caused by overflows	Caused by overflows

reconstruction process requiring significant economic investment.

Basic Information to be collected

Location:

- Epicenter
- Geological information about the area

Intensity and magnitude of the phenomenon:

- The Mercalli scale measures the intensity of an earthquake according to the effects it has on people and property.
- The Richter scale measures magnitude, that is, the amount of energy released from an earthquake's epicenter as recorded on a seismograph.

History:

- Historical intervals between seismic phenomena

Determination of affected geographical area

One should use the epicenter as a reference point in defining the area affected by an earthquake. The study should be supported with as much relevant planimetric information as possible.

A circle is drawn with its center at the epicenter and its radius ending at the farthest point where the earthquake is known to have been felt at intensity V or greater on the Mercalli scale. This approximate representation of the affected area should be adjusted as more accurate information is obtained. The Mercalli scale may be used and more circles drawn to show affected areas that are more precisely tailored to the type of study to be carried out. For example, a smaller circle would be drawn for a study of physical damage to urban installations than for a study of the areas affected by interruptions in the supply of services. This means that areas where installations have been destroyed can be defined by a new circle whose radius is determined by the farthest place where physical structures are known to have been totally or partially destroyed (see figure 1).

Figure 1

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Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows in what part of the country the phenomenon took place.
- Regional level: 1:500,000 - 1:50,000. This level shows the location of the event and the entire affected area (both rural and urban) in greater detail.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are more commonly used in urban areas.

B. Atmospheric phenomena

Phenomenon

- Tropical storms and hurricanes
- Heavy rains
- Droughts

Consequences

The heavy rains and high winds produced by tropical storms, hurricanes and other atmospheric phenomena, such as the rainstorms that occur in Central America and the Caribbean, may cause considerable damage.

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	*****	*****	*****	*****	*****	*****

Effects on the Environment

Effects	Soil erosion and silting of river beds	Water pollution	Land pollution

Abnormal periods, in which rainfall is reduced or the dry season gets longer, often occur in the region. They have a negative impact on agricultural production, power generation at hydroelectric plants and, at times, the supply of water for human and industrial use.

Basic information to be collected

Location:

- Geographical areas affected

Intensity:

- Rainfall
- Wind speed

History:

- Historical intervals between atmospheric phenomena

Determination of the affected geographical area

The best tools for identifying an area affected by a hurricane or similar meteorological phenomena, such as rainstorms, are satellite photographs, which can be obtained via the Internet. Photographs of this sort clearly define which areas have been affected day by day and make it possible to locate the key points in order to mark out the affected area.

Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. It basically shows in what part of the country the phenomenon took place. In the case of atmospheric phenomena, the scale often must cover several countries and indicate the phenomenon's path.
- Regional level: 1:500,000 - 1:50,000. This level shows the entire affected area (both rural and urban) in greater detail.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are more commonly used in urban areas.

C. Hydrological phenomena**Phenomenon**

- River flooding
- Heavy seas
- Desertification
- Erosion

Consequences

This type of phenomenon will have different effects, depending on whether flooding takes place slowly or quickly.

- Slow evolution: minimal fatalities and injuries, damage to crops and both immediate and long-term effects on nutrition.
- Flash floods: many fatalities, few wounded, homes destroyed, immediate and long-term consequences for food.

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	*****	*****	*****	*****	*****	*****

Effects on the Environment

Effects	Air pollution	Water pollution	Land pollution

Basic information to be collected

Location:

- Areas affected

Intensity:

- Rainfall
- Peak river flows
- Water volume
- Speed of movement

History:

- Historical intervals between hydrological phenomena

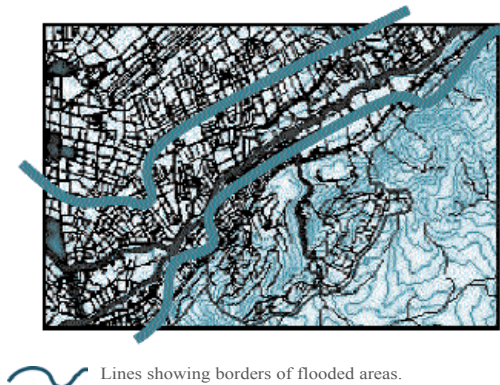
Determination of the affected area

There are two forms of measurement, depending on the type of flood:

- Floods caused by rain or storms can be measured by making a plan and establishing key points according to the information obtained (the triangulation method) or by examining the contours of the land, on the assumption that the lowest areas will be the most prone to flooding. These areas are also defined by geomorphic formations such as canyons.

- In the case of flooding caused by swollen rivers or tsunamis, the river's normal course or the beach line are taken as the base line. From there, parallel lines may be drawn, as reports arrive of affected areas (see figure 2). This information should be complemented with information about the sector's geographical conditions, such as contour lines, slopes, hills and so forth.

Figure 2
DEFINITION OF THE AREA AFFECTED BY FLOODING



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Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows the location of the event so that it can be seen in the context of the country where it occurred.
- Regional level: 1:500,000 - 1:50,000. This level shows the total affected area in greater detail and takes into account tributaries that might cause further floods later.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are generally used more in urban areas.

D. Volcanic phenomena

Phenomenon

- Rock ejections
- Pyroclastic eruptions
- Mudflows
- Lava flows
- Poison gas emissions
- Acid rain
- Pollution from toxic gases

Effects

Volcanic eruptions cause two kinds of direct damage, which may be found separately or together in a single event. However, the area affected by them can vary widely, depending on conditions such as wind and geographical agents.

- Damage caused by pyroclastic eruptions (the emission of ash and toxic gases into the air).
- Damage caused by lava flows.

42 Effects on urban infrastructure

- Fires
- Roofs collapsing under the weight of the ash
- Destruction caused by mudflows

Effects on health

- Injuries, broken bones, burns
- Worsening of respiratory ailments
- Bronchial irritation
- Asphyxia caused by inhalation of carbon dioxide
- Intoxication caused by hydrosulphuric acid and carbon monoxide

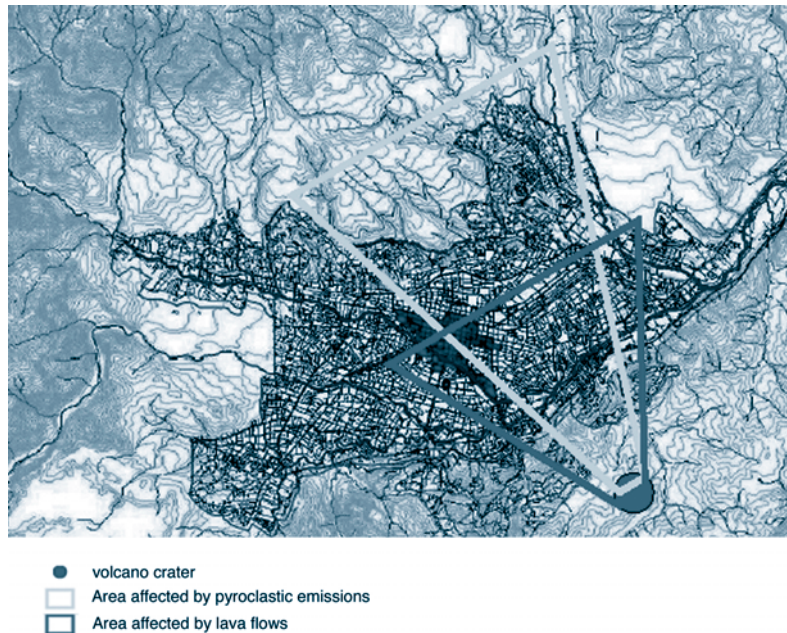
Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	*****	*****	*****	*****	*****	*****

Effects on the Environment

Effects	Air pollution	Water pollution	Soil pollution
	*****	*****	*****

Basic Information to be collected

- Location:
Location of the volcano and its relationship with its nearby surroundings
- Intensity:
Volume of ash emissions
- History:
Historical intervals between volcanic eruptions



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Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows the location of the event so that it can be seen in the context of the country where it occurred.
- Regional level: 1:500,000 - 1:50,000. This level shows the entire affected area (both rural and urban) in greater detail.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are more commonly used in urban areas.

APPENDIX II

PROBLEMS RELATED TO AVAILABILITY AND USE OF INFORMATION IN ASSESSING THE EFFECT OF DISASTERS

Specialists normally find it difficult to determine which information is the most reliable when they first embark on assessing a disaster. Not only is there often a lack of up-to-date information, but access may be limited, and information from different sources can be contradictory and of uneven quality depending on the variable and the geographical unit in question.

Some of these problems are described below and possible solutions to them proposed. We wish to emphasize that these are strategies for approaching the problems rather than specific solutions for all occasions.

Among the problems that are commonly found are the following:

- Difficulties in assessing the quality of basic information on fatalities and the number of other victims.

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Information on the number of victims is often gathered by different organizations, and there is a risk of duplication. Also, there is a risk of overestimating the number of missing persons -which is often added to the number of fatalities- due to the challenge of adjusting figures when a person assumed to be missing is found. Another serious problem arises when estimating the number of people who have sustained losses. This figure can vary widely depending on when those living in shelters were counted.

A related problem that hinders future in-depth studies is the lack of information broken down by sex, age or other socio-economic variables.

In view of the above, we suggest reviewing and evaluating the estimated numbers of victims, including the dead, and obtaining as much information as possible regarding the demographic and socio-economic characteristics of the affected persons.

- Lack of consistency in data-gathering activities.

After a disaster, the institutions responsible for providing emergency assistance normally conduct surveys of the affected population. These are usually taken at shelters. Unfortunately, different methodologies are often used and the data are gathered on different dates, which means that the figures are not strictly comparable.

To avoid these complications, a single data-gathering activity should be coordinated as soon after the event as possible. Since this can be a time-consuming exercise, we recommend that it be conducted at shelters and that only a minimum of information be gathered. Questionnaires used in this type of survey often seek information that, although theoretically useful, is never analyzed. A basic set of questions should be designed to collect the following information:

- First name and surname(s)
 - Sex
 - Age
 - Educational level
 - Family members present in the shelter (e.g., father, mother, etc.)
 - Sex and age of any family member who died
 - Present state of health (e.g., symptoms of acute respiratory problems, diarrhea or other contagious disease)
 - Losses sustained by the family (e.g., house, domestic goods, farm animals, etc.)
- Availability of cartographic data.

The countries in the region are increasingly using digital cartography at an aggregate level and at the city and town levels, as well. When analyzing the effects of a disaster, use should be made of the most up-to-date maps available. In many cases, this information comes from the national statistics office or from cartographic organizations. Also, as a result of decentralization, many local authorities have developed their own geographical information systems, so they, too, may have up-to-date maps of the areas under their jurisdiction. Part of the disaster assessment process should be to determine which material is available and how up-to-date it is.

- Need for a data-gathering strategy to assess medium-term effects of disasters.

A detailed assessment of the indirect effects of disasters in the medium-term can only be made if there is a post-disaster strategy that makes it possible both to assess the progress of the reconstruction process and to determine, say, the patterns of post-disaster migration or the effects of the disaster and subsequent aid on living conditions.

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APPENDIX III ESTIMATING THE POPULATION OF AFFECTED AREAS WITH REDATAM

There are many software packages that professionals can use to quickly and easily process data taken from censuses and other sources, organizing it into hierarchical databases for any user-defined geographical area (such as a group of city blocks). One of these programmes, which was developed in-house by CELADE, is called Redatam. Its validity and usefulness has been tested during recent ECLAC assessment missions. The main features of Redatam+G4 are described below.

What can Redatam+G4 do?

It makes it possible to process information in very large compressed databases (created in Redatam+G4 format), such as population and agricultural censuses, household surveys, etc., which contain data on millions of people, housing units and homes. Consequently, a Redatam+G4 database normally contains micro-data, that is data or variables linked to individuals, housing units, homes or other information elements from which different tables can be generated for any geographical area previously defined by the user. This data is hierarchically organized for rapid access and processed to find specific results for defined geographical areas of interest.

New variables can be derived and tables and other statistical results processed rapidly using graphic interfaces, without the assistance of a programmer.

Example of Redatam+G4 in use

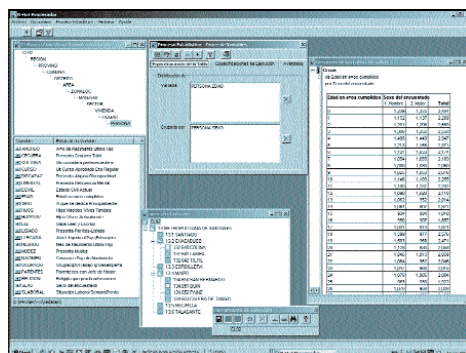
Information is needed on the age and sex of the people in an area that has been affected by a disaster.

The procedure for obtaining the required results is as follows (see figure 1):

1. Open the database dictionary (with levels and variables).
2. Create a geographical selection with the area to be analyzed. Select File/New/Selection from the main menu. Expand the area tree to display the areas to be selected and double click. Name the selection and save it.
3. Open the Statistical Process window by choosing the cross-reference variables option from the Statistical Process menu.
4. Use the mouse to select the variable to be processed from the Dictionary window.
5. Select the name of the variable and drag it to the empty box in the process window.
- 46 6. Fill in the box(es) with the variable(s) to be processed, according to whether a frequency, cross-referencing of variables, or average is required.
7. Start the statistical process by clicking on the Start icon

Figure 1

REDATAM +G4 WINDOW WITH THE DICTIONARY, PROCESS, AND GEOGRAPHICAL SELECTION DISPLAYED

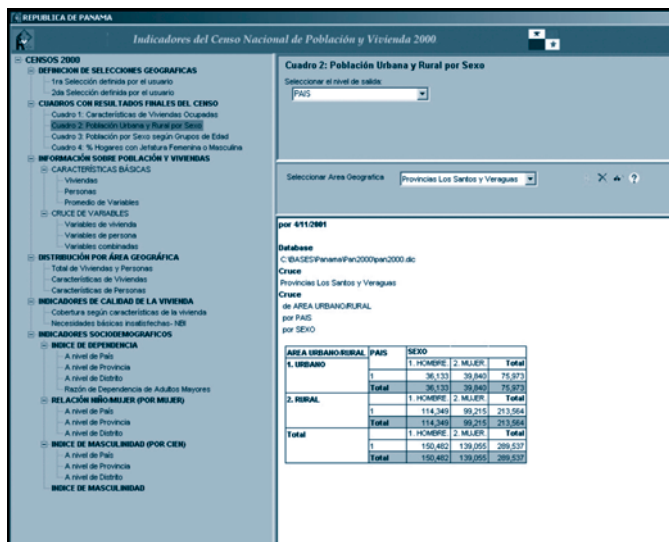


R+G4xPlan (pre-designed interfaces)

The RxPlan tool provides controlled access to the information contained in a Redatam database. No understanding of its mechanism or internal operation is needed to use this tool, which provides an easy-to-use, user-friendly interface to access the information. Its operability is commanded through the INL file.

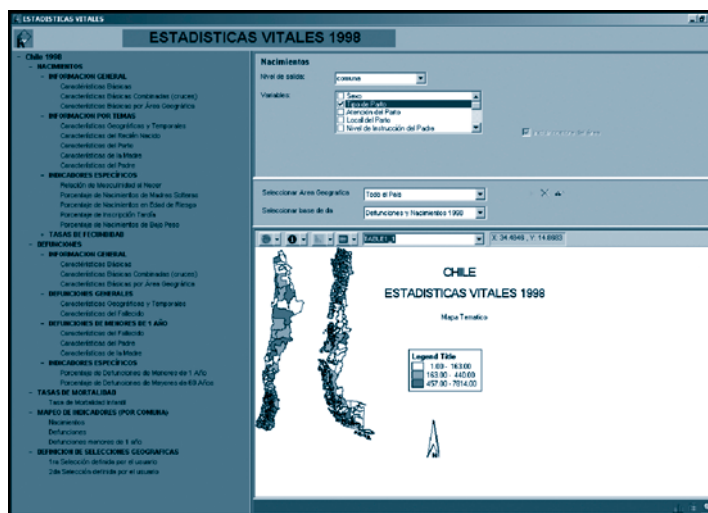
An RxPlan can be loaded with information on the existing population before a mission to assess the impact of a disaster is started. This makes it possible to use the information in the field without having to be an expert in Redatam or other software.

Figure 2
Example of a plan with a population census (Panama)



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Figure 3
Example of a plan with vital statistics (Chile)



APPENDIX IV

THE USE OF GEOGRAPHICAL INFORMATION SYSTEM (GIS) TO ANALYZE INFORMATION GATHERED BY DIFFERENT SECTORS

A Geographical Information System (GIS) specifies a set of procedures in a non-graphic or descriptive database of real-world objects that can be represented graphically and whose dimensions can in some way be measured relative to the area of the world. Apart from a non-graphic specification, a GIS also has a graphic database of geo-referenced or spatial information, which is linked to the descriptive database. Information is considered geographical if it is measurable and has a location.

A GIS uses high-powered graphic and alphanumeric processing tools that are equipped with procedures and applications for inputting, storing, analyzing and visualizing geo-referenced information.

A GIS is useful mainly because of its capacity to build models or representations of the real world from information in databases. It achieves this by implementing a series of specific procedures that generate still more information for spatial analysis.

48 A valuable tool can be achieved by building simulation models that make it possible to establish the different influence factors by analyzing natural disasters or phenomena related to trends in time or space. GIS is therefore important for aiding hazard prevention and for simulating the damage that would be caused in the event of a natural disaster. GIS can also be used to interpret information by creating thematic maps that show the spatial distribution of the information. These maps show spatial patterns, trends or relationships, making it easier to analyze the information.

This is the case in the various successive stages of the process of assessing the damage caused by a disaster. The following possible uses of this tool are related to this point. A GIS makes it possible to modify the display of cartographic information by changing colors, symbols or values. This makes it possible to analyze the information from its spatial dimension in order to reveal patterns, relationships or trends.

A GIS is dynamic. Maps created with a GIS are not limited to just one moment in time. A map can be updated simply by updating the information linked to it. This operation is easy and quick and requires no special training.

Example:

THE JANUARY AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR

Data gathered:

- According to the figures provided by El Salvador's National Emergency Committee, in the housing sector, 222 773 housing units (18 percent of the country's total stock of 1 259 697 urban and rural private housing units) were affected.

- Damage in the housing sector occurred throughout the country to differing degrees. The most affected provinces are Usulután, (with 74% of housing damaged), San Vicente (with 69%) and La Paz (with 64%). In other affected provinces, such as Sonsonate, La Libertad, and Cuscatlán, figures of between 20 percent and 30 percent were recorded.
- Per capita damage varied from less than 100 US dollars to more than 1,000 US dollars.

Any of these data can be displayed on a map:

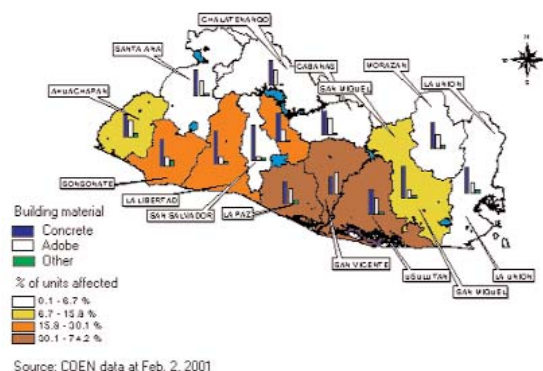
Map 1
GEOGRAPHICAL DISTRIBUTION OF EARTHQUAKE DAMAGE JANUARY - FEBRUARY 2001



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With a GIS, different information can be fed into the same map. The mapping tools can then be used to modify the graphic representation to find spatial patterns and relationships, as shown in the following examples.

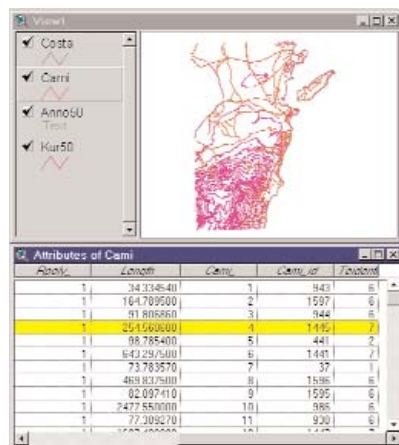
Map 2
IMPACT OF JANUARY 13, 2001 EARTHQUAKE
PERCENTAGE OF HOUSING UNITS DAMAGED BY DEPARTMENT
(Bar graph indicates breakdown by building material)





A GEOGRAPHICAL DATABASE

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A GIS links the spatial data with descriptive information about some particular feature of a map. The information is stored as attributes or characteristics of the element that is represented graphically. For example, a road network may be represented by road centerlines, in which case a true visual representation would not provide much information about it. To obtain information about the road network, the user would consult the stored tabular data for roads, which might describe the class of roads, their width, type of surface, number of side roads, street names and ranking. The user can then create a display that represents all the roads according to the type of information required (see the following figure).

A GIS may also use stored attributes to calculate new information about a map's elements, such as the length of a given road or the total area of a particular kind of soil.

Users who want to go beyond mere drawing need to know three things about each element stored in the computer: what it is, where it is and how it is related to the other elements (for example, which roads are linked to form a road network).

Database systems deliver a means of storing a wide range of information and updating it without having to rewrite the programmes every time new data is input. In a GIS, the software handles the location of the elements, their descriptions and the way in which each characteristic is related to the rest.

A GIS allows the user to associate descriptive information with a map's elements, create new relationships that can be used to determine the layout of different sites for development, assess environmental impact, calculate crop volumes, identify the best location for new facilities, and so forth.

A GIS's capacity for data integration makes it possible to look at and analyze data in powerful new ways. Users can access information in a database table from a map or they can create maps based on the information in the table. For example, they can select a municipality on a map and display a list with all the relevant information about its population. Going the other way, users can also create a map of municipalities and display each of them according to the number of children, adults and seniors in their populations.

GIS COMPONENTS

A GIS has several components:



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A GIS consists of hardware and software tools that use specific methods to perform operations on a database. The database is a simplification of the real world. The GIS user also becomes a vital part of the system when more sophisticated analyses are required. If queries about a place cannot be answered exclusively from the database screen, derived data may be required. Such derived databases are often the result of the effect of a model. A model is structured as a set of rules and procedures for deriving new information that can be analyzed by a tool such as a GIS and used to assist in problem - solving - and planning.

A GIS's analytical tools are used to build spatial models. The models may include a combination of logical expressions, mathematical procedures and criteria, which are used to simulate a process, predict an effect or imitate a phenomenon. Making the models calls for the tools found in a GIS, the ability to choose and use the right ones and great familiarity with the data being used. A GIS offers a great number of tools for analyzing the information in a spatial database.

When users wish to make a query or review a theme related to a spatial phenomenon, they can use a GIS to derive new information by creating a model that performs the analytical procedures. They can then examine the results from the model. This process, which is known as spatial analysis, is useful for evaluating suitability and capacity, estimating and predicting, and interpreting and understanding. There are many kinds of spatial analysis in a GIS, including contiguity analysis, proximity analysis, demarcation operations, surface analysis, network analysis and analysis based on the minimum element. These different forms of analysis include combined relational and spatial operations, as well as logical operations.

PROXIMITY ANALYSIS

How many houses are located less than 100 meters from a watercourse?
 How many customers live within a 10 km radius of a given shop?
 What percentage of alfalfa is within 500 meters of the silo?

To answer these questions, the GIS technology uses a process known as buffering, which determines the relationships of proximity between the elements (see the following figure).

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LINKING ELEMENTS AND ATTRIBUTES

As mentioned above, the power of a GIS lies in the link between graphic (spatial) data and tabular (descriptive) data. Three are features noteworthy in this respect:

- A one-to-one relationship is conserved between the map elements and the records in the element attributes table.
- The link between element and record is conserved by a unique identifier assigned to each element.
- The unique identifier is physically stored in two places: in the files containing the ordered pairs (x, y) and in the corresponding register in the element attributes table. A GIS automatically creates and conserves this connection.

Combined relational operations

In addition to keeping the elements and their attributes up to date, the previously described concept can be used for other functions. Either of the tables can be connected provided they share an attribute in common. A 'relationer' uses a common item to establish temporary connections between the corresponding registers in the two tables. In a relation, each record in one table is connected to a record in another table that shares the same value for an item in common. A relation has the effect of making a table of attributes 'larger' by temporarily adding attributes to it, which are not really stored there. An example of this can be seen in the following figure.

A relation temporarily connects two attributes tables by using the item they have in common.

In a GIS, a database that contains descriptive attributes can be joined to an element attributes table. If a relation is used, the file of related tabular data can be kept and updated separately. For example, the registers in tax files can be applied to a map showing plots of land, provided that each plot is identified with a unique number. Census data on land can be related with polygons using the number of plots of land contained in both.

Fips	Cnty_id	Cnty_tps	Sub_region	Stat_flag
6001	1526	1	Pacific	1
6003	1384	3	Pacific	1
6005	1430	5	Pacific	1
6007	1053	7	Pacific	1
6009	1466	9	Pacific	1
6011	1139	11	Pacific	1
6013	1502	13	Pacific	0
6013	1472	13	Pacific	1
6015	636	15	Pacific	1
6017	1325	17	Pacific	1
6019	1783	19	Pacific	1
6021				

Fips	Cnty_name	Inc.p.cap
6001	Alameda	12468
6003	Alpine	11039
6005	Amador	9365
6007	Butte	9047
6009	Calaveras	9554
6011	Colusa	8791
6013	Contra Costa	14563
6013	Contra Costa	14563
6015	Del Norte	7554
6017	El Dorado	10927
6019	Fresno	9238

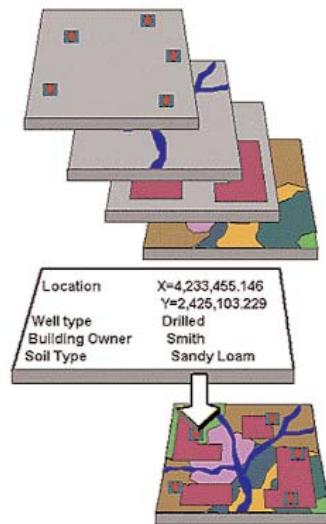
53

Combined spatial operations

Relations and unions are among the basic operations of a GIS. They are simple in concept and are often used. For example, when a spatial superimposition is created, each new output element has attributes from the two sets of input elements used to create it. The superimposition of polygons is essentially a spatial union. In this case, instead of using a common item from two tables, the records are paired on the basis of the location of their associated geographical elements.

In the figure below, a coverage layer of populated centers is combined with layers for the hydrographic system, zoning and relief. When these coverage layers are superimposed, the spatial information is combined, as are the attributes, and a combined coverage is produced.

The possibilities of a GIS are based on its ability to carry out the many kinds of spatial analysis needed to answer the wide range of questions that people might have. A GIS can carry out all these operations because it uses geography or space as the common key between the data sets. Information is related only if it refers to the same geographical area.



Like other information systems, a GIS confirms the saying that better information leads to better decisions. A GIS is not, however, an automated decision-making system. On the contrary, it is a tool for analyzing, querying and displaying geographical information that can be used to assist in decision - making. GIS technology is used to create scenarios that help us to make the best decision when solving a problem.

Finally, it is important to mention that the development of personal computers has now brought GIS technology within the reach of everybody. A GIS now makes it possible to perform complex, sophisticated spatial operations with a desktop computer.

QUESTIONS THAT A GIS CAN ANSWER

A simple GIS programme, such as ArcView®, MapInfo®, IDRISI® or GISMAP®, can be run

on a PC to answer many of your location-related questions by making use of existing data.

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The following are examples of typical questions that a GIS can help to answer.

Location: What exists in ...?

The first of these questions attempts to discover what exists in a particular location. A location can be described in many ways, including place name, postal code or geographical references, such as latitude and longitude.

Condition: Where ... ?

The second question is the opposite of the above and requires spatial analysis before it can be answered. Instead of identifying what exists at a given location, you may wish to find a place where certain conditions are met (for example, a non-forested piece of land with an area of at least 2,000 square meters, 100 meters from a road and with soil that is suitable for building).

Trends: What has changed since ...?

The third question, which might include the first two, attempts to find differences within an area over a given period of time.

Patterns: What spatial patterns exist?

This question is a more complex . You might ask it to find out whether cancer is the leading cause of death among people living near a nuclear power station. Or you might want to know how many anomalies from a pattern there are and where they are located.

Creating models: What would happen if ...?

This type of question is asked to find out things such as what would happen if a new road were added to a highway system or if a toxic substance were introduced into the underground water supply system. Specific geographical and other information is needed to answer this type of question.

The questions included when creating models call for the generation of additional data (using a complete GIS, such as ARC/INFO), based on existing geographical data. The following are some typical question-asking techniques.

Proximity: What are the characteristics of the area around the existing elements?

Provide a summary of the types of vegetation to be cleared within 100 meters of a fire cut-off for a high-voltage power line; inform the fire brigades about the nearest watercourse at the time of fighting a forest fire; notify the owners of wells within three miles of a toxic waste dumping site of possible pollution; warn all owners within 500 meters of a proposed change of site. All these problems can be solved with the proximity analysis tool: generation of intermediate memory areas or calculations of "intra-characteristic distance".

Limiting operations: What exists within a specific region?

Examine a problem, test a hypothesis and define alternative courses of action for the prototype areas in order to apply a model to an entire area of interest. You will sometimes wish to create data for specific areas of study. The limit operation tools can separate specific areas or they can extract elements from within a particular area.

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Logical operations: What is unique for a region or a set of elements?

Examine soils with a particular alkalinity; study roads built with a specific kind of surface; study wells that are deeper than their design depth. The answers to some questions about spatial elements can be found in their tabular attributes rather than their location. Elements can be extracted from databases or introduced into them by using logical operations.

Spatial union: Where is something?

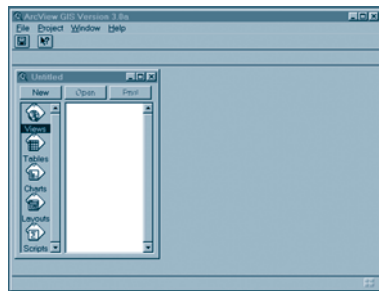
Establish area division discrepancies; establish wildlife habitat requirements; determine which parts of a right-of-way fall inside land whose ownership is in dispute. Many questions can be answered with spatial union operations, which are often referred to as the "superimposition of polygons". Spatial union operations provide new elements for the existing attributes.

NOTES ON USING ARCVIEW©

A spatial database may contain information about natural phenomena, artificial characteristics, limits, properties, etc. ArcView is a utility that creates an onscreen environment and queries the contents of a spatial database. ArcView allows users to explore the database, show all or part of its contents, query, display or save results and feed information to graphic and other applications.

THE ARCVIEW INTERFACE

The ArcView interface consists of windows, menus, a tool bar and a status bar. Like all programmes that run under Windows, ArcView is driven by menus that are activated by selecting options or clicking on icons. It is also extremely intuitive and user-friendly in its operating sequence.



ArcView's main window is the applications window. All ArcView operations are executed from there. This window can be resized, minimized and maximized with the mouse.

To load and display a coverage, an ArcView project must first be created, since every working session is saved in projects (file extension .apr). A project contains all the views, tables, graphics, cartographic compositions and macros that you need for a

given application. This means that all your work is saved in the same place.

The projects window organizes and lists the contents of the active project and makes it easier to manage and control work. A new project will be named 'untitled' until given a new name. See left figure.

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The tool bar is just below the menu bar. The icon buttons are used to activate given functions immediately without having to access them through a menu option. When the cursor passes over an icon on the tool bar, a description of its function appears in the bar at the bottom of the screen. At the start of an ArcView session, the main applications window contains only two buttons: one to save a project, the other to access the online help.



As you work with ArcView, the tool bars at the top of the screen change according to which window is active (a view, a table of attributes, graphics, etc.).

The following figure is a screenshot of several buttons grouped together. Each set of icons or buttons is used to activate different functions. For example, the tool bar in the second row beneath the main menu is used for operations that you might want to carry out on a map displayed in a view: request information about an element in the map, select an element, edit vertices, select a set of elements, zoom in and out, pan, measure, etc.



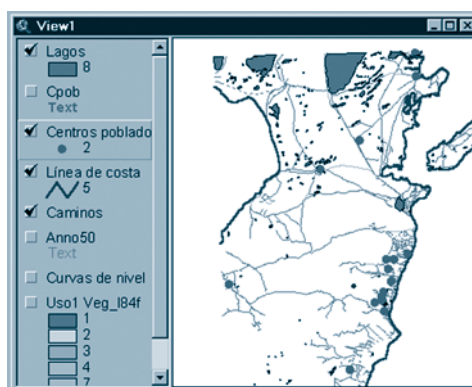
TYPES OF ARCVIEW DOCUMENTS

Boxes, tables, diagrams, schemes and macros handled in ArcView are known as documents. Each kind of document is briefly described below.

Views

A view is an interactive map that displays, explores, queries and analyzes geographical data. A view defines how the geographical data you are using will be displayed, but does not itself contain the geographical information.

A view can be thought of as a collection of themes. A theme is a collection of geographical phenomena defined by the user. The figure at right shows the view titled 'View 1', which shows the Punta Arenas sector in Region XII of Magallanes, Chile.



The view has a table of contents (or legend), which lists the themes being reviewed. The components of the view can be determined by looking at the table of contents. In the figure above, the window displays and lists the contents of the view.

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Roads	Length	Cami	Cami_id	Tercid
1	34.334540	1	943	6
1	164.789500	2	1597	6
1	91.806860	3	944	6
1	254.568860	4	1445	7
1	98.785400	5	441	2
1	643.297500	6	1441	7
1	73.783570	7	37	1
1	469.837500	8	1596	6
1	82.097410	9	1595	6
1	2477.550000	10	986	6
1	77.309270	11	938	6
1	1607.422000	12	1447	7
1	1113.690000	13	1595	6
2	932.719700	14	1590	6
1	1902.576000	15	947	6
1	1506.057000	16	1464	7

Table of Attributes

Tabular data are stored in a table. You can display, query and also analyze almost any kind of tabular data, such as geographical aspects, types of soil, road conditions and so forth.

Graphs

Graphs allow the user to show numerical information in a graphic form. A graph makes it possible to visually compare the behavior of one variable with that of another. ArcView provides several options for creating graphs that can accompany the display of attributes in a map

Cartographic compositions

Cartographic compositions allow users to locate every type of document in a single window and produce a final map. Instead of being copied directly, views, tables and maps can be referenced within a cartographic composition. In this way, changes to any of the elements are automatically reflected in the composition. You can add elements (titles, legends, bar scale, texts, arrow to indicate North, etc.) to the cartographic composition.



Macros

A macro is a set of commands written in the language known as Avenue that allows users to manage the database in ArcView transparently. You can use Avenue to design your own interface to access ArcView.

All documents are managed through the project control window. Each type of document is represented by an icon, which, when selected, will display a list of all the documents of this type contained in the project.

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REPRESENTATION OF ELEMENTS ON THE MAP

Geographical phenomena are represented in the database by geometrical elements like polygons, lines, and points.

The geographical phenomena are known as classes of elements:

- Polygons might, for example, represent plots of land whose rateable value is within a certain range or parts of forests that contain particular species.
- Lines might represent paved roads, paths or drains of a specific diameter.
- Points might represent the location of warehouses, customers, wells or significant places.

AN ARC/INFO® COVERAGE

A coverage is a digital version of a map. It is the basic object that stores the geographical data (geographical elements and their attributes) in ARC/INFO®. A coverage may contain one or more classes of geographical elements. For example, a coverage whose elements are areas or polygons also contains labeled points that identify each polygon. In addition, a coverage containing polygons that represent plots of land may also contain linear elements (arcs) that contain information on the boundaries between the plots. When we add ARC/INFO® coverage to a view, the class of element to be used can be chosen.

ARCVIEW PROJECTS

A project is a space (with an .apr extension) that ArcView creates so that you can organize your work and documents in one place (or file). A project makes it easy to maintain and manage any combination of interrelated ArcView components. Views, tables, maps, cartographic compositions and macros can all be worked on and saved simultaneously in one file.

When you create an ArcView project, you create a file that contains the views, maps, plans and documents that make up the project.

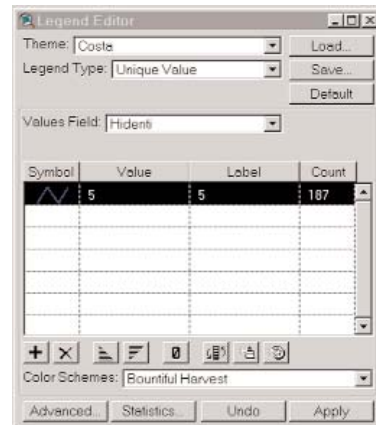
THEMES IN A VIEW

ArcView uses geographical information from a variety of databases to display a given geographical characteristic or theme in a view. Examples are spatial databases, including ARC/INFO coverage, configured ArcView files and satellite image data. ArcView also supports tabular (alphanumeric) databases that contain geographical information, such as street addresses and x,y coordinates.

The definition of the theme might simply be a request to display the complete database referred to in the theme, or it might be a set of criteria applied to the database to identify which part of the data should be displayed. A database is an ARC/INFO coverage or an image file. The image may have been scanned, or it may come from a satellite.

Themes can be given any name. A theme might be named according to the database to which it refers, such as, USENOW (present use of land), P3716 or COV143. It might also be named according to the criterion that it meets, as in, "Appropriate areas for development," "Soil code = 5," or "Model 2 results."

Each theme represents a set of geographical elements that have a given characteristic or attribute. This characteristic or attribute is reflected cartographically by means of a determined symbology that is shown in a legend. A legend controls the way in which the elements in a theme are drawn. It consists of symbols, such as patterns that fill an area, types of lines that trace a linear feature or marks that show the specific location of a point (see right figure).



The symbols can be drawn with a great variety of colors. A theme can be displayed by using the same symbol and a different color or vice versa. For example, all the roads can be drawn with a broad red line or shopping centers can be represented with a yellow flag. ArcView provides a color palette for this purpose (see following figure).



Since themes are derived from a geographical database, they generally contain geographical elements associated with a table of attributes. All the elements of a theme can be drawn on the basis of a particular attribute value. For example, each water main can be drawn in a different color or with a different thickness according to its diameter if diameter is an attribute of the linear elements that represent pipelines.

Elements can be classified and then symbolized in accordance with the classification scheme, or each unique value for an attribute can be drawn. For example, types of soil can be shaded according to their alkalinity; regions can be colored according to their net migration figures; or plots of land can be shaded with a unique pattern or color according to existing holdings.

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As you get used to ArcView, you will learn how to use the table of contents to control which themes are visible. It is possible to display all or just some of the themes on one screen. You can also control the order in which the themes are displayed. Each theme points to a coverage stored in a database somewhere in the system. The data can be stored on a local disk or on a disk in a network. Although many themes can be derived from the same coverage, an individual theme can only refer to one attribute of that coverage.

Although a theme can contain only one class of element (polygon, line, point or text), it can be derived from a coverage that has more than one type of element. For example, a coverage formed by censused city blocks (polygons) and the fronts of each block (lines) has a topology for the polygons and the linear elements, but the theme based on this characteristic can only display one of them. Another theme can be created to display the attributes of the other class of element.

TABLE OF ATTRIBUTES

Address	Length	Color	Class	Topology
1 34.3348481	1	943	1	1
1 164.799500	2	1597	2	6
1 91.899999	3	944	3	6
1 25.1540000	4	144	4	7
1 98.795400	5	441	5	2
1 46.7297500	6	1441	6	7
1 73.783570	7	37	7	1
1 46.8137500	8	1598	8	1
1 62.007110	9	1595	9	6
1 74.7850000	10	885	10	6
1 77.389270	11	930	11	6
1 1.1	12	1.1	12	6

Spatial databases (e.g., ARC/INFO©) have a table of attributes associated with the geographical elements, which contains descriptive information. When a theme is displayed in a view, a table of attributes is immediately associated with the displayed elements (polygon, line, point or text).

If you have numerical information in an external file (in dBase, INFO, or comma- or tab- delimited ASCII format) that is related to the elements displayed in your view, it can be added to your ArcView project like any other table. These files generally contain additional information on the elements displayed in a view. It is also possible to create a table in ArcView to enter information interactively.

We have given basic information about ArcView operation and document handling. For a more detailed explanation of the programme's functions and operations, see the User's Manual for ArcView 3.0.

THE ROLE OF ARCVIEW IN SPATIAL ANALYSIS

As mentioned previously, ArcView© is a display and querying tool that can carry out many tasks included in the spatial analysis of ARC/INFO© geographical databases. ArcView can be used with more than one coverage or database. Since display and query are essential for interpreting the results of spatial analyses, ArcView complements the spatial analysis carried out in ARC/INFO©, by making it possible to investigate the results and new spatial relationships derived from analytical procedures and models previously made with ARC/INFO©.

II. HOUSING AND HUMAN SETTLEMENTS

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A. INTRODUCTION

1. General comments

This chapter of the handbook refers to all buildings used as dwellings, urban infrastructure and equipment. It does not deal with sectors involved in the production and marketing of construction materials or directly engaged in construction, as these industries are discussed in the chapter on productive sectors.

The interrelations with other economic activities and social segments must be taken into account when analyzing this sector since the deterioration or destruction of housing has broader effects on the living conditions and economic performance of the affected country or region. When housing is hit by a major disaster, the micro, small and medium-sized businesses located in those homes are similarly affected, as are household incomes. Many of these enterprises are owned and operated by women. Spending on the construction (and reconstruction) of housing contributes to the gross formation of fixed capital in the economy. Any change in housing construction rates—such as would occur after a major disaster—has significant implications for employment and for industries related to the construction sector. Thus, any negative effect on housing has ramifications for other sectors that must be identified and taken into account both in assessing the overall impact of the disaster and especially in defining reconstruction strategies and plans.

Pre-disaster conditions should be considered in impact assessment and when drafting reconstruction plans, since a disaster often aggravates pre-existing housing deficits. Actions in the field of housing are a primary aspect of national social development policies through which governments try to satisfy the population's housing needs. Responsibility for designing and implementing such initiatives falls not only on central government authorities, but also increasingly on regional and local governments or agencies, and even on non-governmental organizations.

When assessing damage or drawing up reconstruction plans, one should provide some idea of the effect that both have on employment, as well as on the installed capacity of the industrial and commercial sectors that provide the necessary inputs.

2. Assessment procedure

The housing and human settlements sector specialist –like the other specialists on the assessment team– usually has from one to three weeks' notice prior to visiting the affected country or region and from one to two weeks for field work. Before embarking on the mission, the specialist must collect all relevant information on the housing sector in the affected area or country and prepare a list of the institutions and people to be contacted during the field visit.

- 62 The specialist must keep in mind that at the end of the mission, he/she will be expected to develop a summarized table of damage to the sector. It should specify the amount of direct damage and indirect losses, broken down by property type (private and public), and indicate how they are distributed between the geopolitical units previously agreed upon among members of the assessment team. Table 1 provides an example of the type of table that the housing and human settlements specialist is expected to produce.

Table 1
DAMAGES TO HOUSING AND HUMAN SETTLEMENTS
(Millions of dollars)

Item	Damage			Sector		Cost of reconstruction	Imported component
	Total	Direct	Indirect	Private	Public		
Total							
Public schools							
National University							
Private schools							
Sports centers							
Cultural heritage							
Houses of culture							
Town halls							
Houses in historic centers							

The housing and human settlements specialist will also have to ascertain the sector's effects on the main macroeconomic variables –the external sector, public finances, etc.– and provide it to the team's macroeconomic specialist. Likewise, he/she will have to work with the employment specialist to determine the impact on jobs for both the disaster and reconstruction phases. He/she must also work in close cooperation with the gender specialist in order to determine the differential impact on women, as well as the possible implications of these gender differentials for reconstruction plans and projects.

The following is a guide to the normal sequence of procedures the specialist should follow:

- Definition of the geographical area in which the sector was affected using the standard methodology described in the previous chapter;
- Assessment of the pre-disaster situation based on information provided from on-site sources;
- Identification of direct damage or effects;
- Quantification of direct damage or effects;
- Valuation of direct damage or effects;
- Identification of indirect losses;
- Quantification of indirect losses;
- Valuation of indirect losses;
- Development of a typology of affected housing according to size, prevailing construction materials and type of ownership;
- Determination of the geographic or spatial distribution of total damage and losses;
- Assessment of corresponding social effects;
- Assessment of macroeconomic effects;
- Assessment of the impact on employment;
- Assessment of the impact on women;
- Collection of available information on reconstruction strategies, plans and projects, as well as on their execution timetable and possible budgets;
- Identification of issues or areas within the sector that need priority support or attention during reconstruction; and
- Helping the relevant authorities formulate definitive reconstruction strategies, plans and projects.

3. Information requirements

Information on the situation prevailing in the housing and human settlements sector before the disaster in the affected area or country is essential for establishing the baseline for the assessment. Minimum information requirements include:

- Number of dwellings in the affected area, specifying for each whether they are rural or urban, single- or multi-family, owned by men or women, privately or publicly - owned;
- Quality of existing dwellings, broken down either by permanent versus temporary units, the type of construction materials used (reinforced concrete, brick, wood, adobe, cardboard, etc.), the degree of conservation (good, regular, poor, etc.) or the type of dwelling (house, mobile home, shack, etc.);
- Average dwelling size by type, taking into account the average number of inhabitants per unit and the average area in square meters.
- The main construction techniques and materials used in the affected area;
- Typical furniture and equipment in the affected area, by dwelling type; and
- Costs of construction, furnishings and equipment.

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Costs must be specified at current market prices with the later application of depreciation coefficients to estimate the current value of lost or damaged assets, as described in the section on direct costs. Costs must be obtained in the local currency of the affected country, and later converted into dollars based on a single official exchange rate for the date of the disaster, which the assessment team should determine in conjunction with the country's financial authorities.

4. Sources of information

Basic information on the housing and human settlements sector can be obtained from both national and international sources.

The following national sources should be consulted:

- Periodic censuses and surveys, including population and housing censuses, statistics bulletins and yearbooks, land registries, periodic housing-sector surveys, construction permits and licenses and consumer price lists;
- National statistics institutes or agencies, housing and urban development ministries or institutes, planning ministries or institutes, construction industry chambers, pertinent trade associations (colleges, associations or federations of engineers and architects), banks or agencies that help finance social housing and academic or research institutions related to the sector;
- Women-focused institutes or bodies that can provide up-to-date statistics;
- Related companies such as construction firms and the producers and sellers of building materials;
- Trade and industry associations;
- Classified advertisements in local newspapers;
- Property and real estate brokers; and
- Insurance companies.

The following international sources can be consulted:

- United Nations statistical yearbooks or compendiums, such as the Statistical Yearbook for Latin America and the Caribbean (ECLAC), the Compendium of Human Settlements Statistics (New York), the Construction Statistics Yearbook (New York) and the United Nations Development Programme's Human Development Report (UNDP) and
- International organizations such as the Latin American and Caribbean Demographic Center (CELADE), the headquarters and subregional headquarters of the Economic Commission for Latin America and the Caribbean (ECLAC), the Women in Development Unit of ECLAC, the United Nations Programme for Human Settlements (Habitat/Kenya), the United Nations Statistics Division (New York) and the Organization of American States (OAS/Washington).

B. QUANTIFICATION OF DAMAGE AND LOSSES

1. Direct damage

a) General comments

As we noted in the previous chapter, direct damage refers to losses of assets and property. Essentially, it includes damage to, or the destruction of, housing, domestic furniture and equipment, and public buildings and urban infrastructure.

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Damage depends on both the type of disaster and the type of construction. Earthquakes normally damage structural elements (beams, joists, panels, load-bearing walls, etc.) and non-structural elements (partition walls, non-structural roofs, furniture, installations, equipment, etc.) because of the additional strains or loads to which such elements are subjected. Permanent deformations of the land such as settling or landslides can also do damage.




The intense winds of tropical storms and hurricanes exert extraordinary pressure on buildings; they can damage structural and non-structural elements even when foundations and other elements located below ground are not affected. Other phenomena –such as volcanic eruptions, mudslides, and floods– also put added stress on buildings and can destroy or damage their components, deform the land on which they are built or render it useless. Water or wind can bury the area in mud, ash or waste.

The most severe damage is generally structural in nature and may be so extensive as to require demolition. Non-structural damage may be more visible but also more susceptible to repair, possibly only requiring the replacement of certain elements that do not affect the building as a whole. Land failure might require either abandonment of a building or soil stabilization efforts.

b) Classification of dwellings

In light of the relatively limited time available for assessment, the housing and human settlements specialist may not be able to obtain a detailed inventory of all affected or destroyed units. In lieu of a statistically representative sample, the specialist may have to settle for extrapolating from what inspections he/she is able to conduct.

The specialist should classify dwellings and public buildings into the three following categories:

	Completely destroyed buildings or those beyond repair;
	Partially destroyed buildings with a possibility of repair; and
	Unaffected buildings or those with only minor damage.

A similar categorization can be made of the destruction or damage to household furniture and equipment.

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By locating on a map all dwellings and buildings affected in accordance with the categories noted above, it is easy to visualize the areas hardest hit and thus requiring priority attention from authorities in producing more detailed studies and defining demolition and debris removal requirements.

In addition, the housing and human settlements specialist must use the following criteria to classify dwellings and buildings according to their pre-disaster state:

- Geographic location (urban or rural);
- Materials used in construction;
- Number of rooms per dwelling, and
- Ownership (individual or collective; leased or self-owned; public or private).

The information must be grouped by the following categories:

- Houses;
- Apartments;
- Precarious housing; and
- Other types of dwellings.

The housing and human settlements specialist will have to clearly describe each of these categories to facilitate reader comprehension of the assessment document.

Differences should be noted between permanent or durable and precarious construction materials. Such distinctions can be useful when teams in the field detect rural settlements built from local materials that are not employed in urban construction. Likewise, dwellings must be classed by number of rooms, thus allowing for a calculation of the average number of rooms for each type of housing unit.

Information on affected dwellings available after a disaster is normally broken down into simple categories such as destroyed or damaged and rural or urban, rather than the classifications used in the population and housing census. In such cases a comparison cannot be made between the census and disaster-impact information. The pre-disaster information obtainable through REDATAM will only be useful for defining the universe of dwellings prior to the event. Comparisons will show that a disaster does not affect all construction equally; rather, "precarious" dwellings tend to be the hardest hit, while the resistance of specific types of construction materials varies depending on the type of disaster. Field surveys along with comparisons of pre- and post-disaster housing data are needed for the specialist to carry out realistic estimates of damage by type and location of dwellings.

Once the typology of the affected housing has been determined –albeit roughly– their pre-disaster values must be estimated based on a uniform measure, such as square meter of construction or per housing unit. Significant national variations make it impossible to define in advance standard housing price ranges for all of Latin America and the Caribbean. These estimates must be made for each case based on local information from construction industry chambers, housing funds, NGOs involved in the sector, housing cooperatives, classified advertisements, etc.

In Central America, the United Nations Programme for Human Settlements employs an evaluation formula comparing one square meter of construction of affordable housing to the prevailing minimum wage. The cost of land and basic services must be added to this calculation. This formula allows for rough estimates, but it is limited by potential variations in the relationship between labor and construction-material costs.

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c) Damage - prone dwelling and building components

It is possible to identify ahead of time the basic components of dwellings and buildings that are subject to disaster damage, thus expediting the later assessment process. These components and the types of damage they are prone to suffer are described below.

i) Buildings. Possible damage to structural and non-structural elements:

- **Structural elements:** beams, joists, panels, load-bearing walls, foundations, etc.
Potentially repairable damage:
Types of damage: fissures, deformities, and partial destruction.
Actions: repair the element and possibly reinforce it.
Irreparable damage:
Types of damage: fissures, deformities, total destruction.
Actions: replace the element, reinforce it or condemn and replace the building.
- **Non-structural elements:** partition walls, internal installations, windows, non-structural roofing, floors, etc.
Potentially repairable damage:
Types of damage: fissures and cracks, deformities, partial destruction.

Actions: repair the element and possibly reinforce it.

Irreparable damage:

Type of damage: cracks, deformities, total destruction.

Actions: replace the element, reinforce it or condemn and replace the building.

ii) Furnishings. For the purposes of the assessment, furnishings are understood as furniture proper (beds, tables, chairs, etc.), kitchen utensils, all clothing, domestic appliances and equipment (stoves, washing machines, radios, etc.) and other items such as decorations, books and games. When possible, it is useful to define typical furnishings (and their value) for each type of urban and rural dwelling that can be identified during the assessment.

Furnishings do not include the machinery or equipment of home-based micro, small, and medium-sized enterprises. Since such ventures are often run by women and are a source of supplemental income, related damages should be estimated separately, in cooperation with gender and industry specialists.

In cases of widespread destruction, time constraints may make it impossible for the housing and human settlements specialist to define with great precision the extent of damage to furnishings and the potential for repair at each site. Therefore, we suggest that the sectoral specialist use field inspections to define two or three basic ranges of damage (e.g., 100%, 50%, 25%) to furnishings in standard dwellings.

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iii) Equipment. In addition to the usual in-house installations such as sanitary and electrical devices, some buildings have air-conditioning or heaters, small electricity generators, potable and waste water pumps, incinerators or other devices for solid waste disposal, elevators, security equipment, recreation (swimming pools and gymnasiums) and irrigation equipment.

Some of this equipment is very uncommon in the region and mostly confined to limited applications in specific climate zones (for example, air-conditioning in tropical areas or heaters in cooler areas). Therefore, the housing and human settlements specialist may wish to adopt one of the following criteria:

- Define and describe "typical equipment" for all affected dwellings;
- Define and describe "typical equipment" for specific types of affected dwellings (this is the most frequently chosen alternative);
- Define for each segment (stand-alone units or apartments, urban or rural, etc.) an average value for furnishings as a percentage of the total value of each housing unit.

Similarly, a detailed inventory of damaged or destroyed equipment may be out of the question. In that case, the housing and human settlements specialist should define two or three damage categories (e.g., equipment needing total replacement, major repairs or only minor repairs) to a dwelling's typical equipment or to individual equipment units considered worth valuing.

iv) **Public buildings.** Government buildings and their furniture and equipment are affected by disasters in the same way as dwellings. While more limited in number than housing units, their complexity and cost is usually much greater; they therefore demand a more detailed application of the procedures described above.

Damage assessment for buildings of historical value should be dealt with separately. Detailed procedures for this purpose are given under the chapter on Education and Culture.

v) **Other direct damages.** It is necessary to record other damages demanding replacement or repair to their pre-disaster state. This includes household connections to public utilities such as water and sanitation services, electricity and –in some countries– gas lines.

The housing and human settlements specialist must also estimate damage to public areas including green zones and public parks or squares.

d) Quantification of damages

It is necessary to determine the replacement cost of restoring destroyed or damaged buildings to their pre-disaster state; in the case of precarious or informal dwellings, qualitative improvements must be introduced that expand unit replacement costs.

Definitive reconstruction costs, including any improvements for disaster prevention and mitigation, must be determined immediately thereafter.

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i) **Buildings, furniture and equipment.** One should begin by estimating replacement costs for instances of total destruction before calculating partial damage costs. Many years of experience have shown that the fastest approach is to determine the number of dwellings affected in each typological category and apply average per square meter construction costs to this figure.

A replacement value should be adopted for informal dwellings that is equal to the cost of the most basic units in any government housing programmes currently under execution.

Damage to partially affected dwellings is estimated by adopting coefficients related to their total replacement cost.

Damage to, or the destruction of, furnishings and equipment in buildings should be estimated based on special surveys to ascertain their average value for each category of affected dwellings.

Where damaged housing and other buildings are determined to have been located in hazardous areas, it is necessary to estimate the cost of the land and ancillary services and deeds needed to rebuild safe places. However, this additional cost should be considered as indirect damages.

ii) **Public buildings.** Since this heading will normally cover a small number of units compared to dwellings, damage to public buildings should be estimated building by building. As in the case of dwellings, replacement cost should be estimated based on the surface area of construction and the corresponding cost of construction per square meter.

In coordination with officials, a specific case-by-case estimate must be made of furnishings and equipment, which undoubtedly will be much greater than in the case of dwellings.

Detailed estimates are needed even when only repairs are called for. One alternative would be to assign a fraction or percentage of the replacement cost.

iii) **Cost of reconnecting public services.** An estimate should be made of the cost of replacing or repairing basic service connections (domestic water, sewer, power, telephone, etc.). The calculation should be based on the number of units totally destroyed or partially damaged. Unit replacement or repair costs will have to be applied later as officials make them available.

iv) **Public areas.** Damage to green areas and public squares or parks should be estimated based on their size in square meters and their unit repair or replacement cost. Estimates for public parks or squares should include the number and repair or replacement cost of benches, lampposts and lamps.

70 Public areas may be classified according to the following categories:

- Parks with a regional or national relevance for the environment (including forest reserves);
- Large parks in an urban setting with relatively important infrastructure and support services and with relevance for the environment;
- Intermediate-sized parks within a local community (or communities), with only minor relevance for the natural environment; and
- Small parks located in small neighborhoods and with little or no relevance for the environment.

v) **The differential impact on women.** As we explain in greater detail in Volume Four, information must be obtained for ascertaining the differential impact on women in each sector.

With this in mind, the housing and human settlements specialist must uncover information on the percentage or number of homes where a woman is the head of household and/or owner of the dwelling or building. Those numbers are needed to determine the extent of women's losses in housing, equipment and furnishings. Losses to home production are taken into account as indirect damage, as described in Volume Four.

2. Indirect losses

a) General comments

In addition to direct asset losses, it is necessary to estimate indirect losses under the following headings:

- The cost of reconstruction-related demolition and debris removal (cleaning costs are dealt with as part of the humanitarian assistance or emergency stage);
- The cost of reducing the vulnerability of housing and human settlements including works to stabilize soil, protect dwellings or reinforce structures;
- The cost of purchasing land to relocate dwellings away from vulnerable places and to install basic services; and
- Temporary housing costs for the period in which new units are under construction or damaged ones are under repair.

Temporary income losses suffered during the reconstruction period by home-based micro and small businesses are addressed in Section Four on productive sectors and as part of the evaluation of the differential impact of the disaster on women since most of those enterprises are owned and operated by women.

b) Estimating indirect losses

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i) Demolition and removal of debris. To repair or rebuild a dwelling or building, it must often be partially or totally demolished and the resulting debris removed. These indirect costs may represent significant portions of total damage, depending on the type of disaster damage.

These costs are different from the considerably lower emergency-related costs incurred during the emergency stage, when certain components of buildings must be demolished or some debris removed in order to locate, rescue and assist victims.

Demolition costs are highly variable, depending on the type of materials used in the construction of damaged dwellings and their location. To facilitate estimates, specialists often use overall unit cost estimates by type of dwelling, multiplied by the number of units affected. The costs of removing debris are often estimated based on the volume to be removed, the unit cost of removing and disposing of debris and the number of each type of affected dwelling units.

ii) Housing and human settlement vulnerability reduction. After a major disaster occurs, a decision may be taken to protect dwellings and other buildings against the possible occurrence of similar phenomena in the future. The cost of land stabilization, flood protection and structural reinforcement should be estimated under indirect damages. Given the wide range of possible endeavors, it is not possible to adopt a single estimate procedure. However, we recommend determining the main work required for each type of dwelling and estimating a unit cost per dwelling. Alternatively, one may estimate the costs for a group of housing units included within one single vulnerability reduction project.

iii) **Relocation of dwellings.** Estimates must be made of all costs for temporarily or definitively relocating human settlements to less vulnerable areas if such relocation is likely. This calculation should not include the cost of evacuation incurred during the emergency stage.

The costs that must be included under this heading include the following:

- The value of the land where new dwellings are to be located;
- The cost for the provision of water, sanitation, power, telecommunications and related basic services;
- The cost of title deeds; and
- The cost of transporting furniture and equipment to their new location.

All these costs can be obtained per square meter of construction or as an overall total per housing unit, and then multiplied by the number of dwellings to be relocated.

iv) **Temporary housing.** The cost of temporary dwellings that must be provided while definitive housing solutions are being prepared is an indirect cost that must also be estimated. The number of temporary solutions must coincide with the number of families who have lost their homes, and not necessarily with the number of dwellings destroyed (which may have housed more than one family per unit), as temporary solutions generally do not allow more than one family to be housed per unit.

72 These alternatives may consist of temporary shelters in buildings normally used for other purposes or ad hoc constructions. When existing facilities such as schools, churches or sports venues are pressed into use, one must estimate the cost of repairing any resulting damage once the facility has been returned to normal use, as well as the cost of not carrying out the activities for which the buildings are normally intended. This cost must be registered under the corresponding sector (such as schools under education) rather than under housing and human settlements.

When temporary camps or shelters are built, it will be necessary to estimate the cost of construction and related services, such as the provision of water, latrines and electric power. These costs are normally estimated on the basis of the number of square meters and the unit cost of construction of each temporary housing solution, combined with the number of dwellings or homes involved. Temporary solutions in this case do not refer to shelters used to provide humanitarian assistance during the emergency stage, but to ones of a longer duration such as when the decision is taken to postpone reconstruction until after the rainy season ends. In the case of ad hoc housing, the unit value will depend on its technical characteristics.

While officials in the disaster area may have to choose among a wide range of alternatives, we generally recommend using construction materials that can later be used to build or rebuild permanent housing.

3. Sources of information on direct and indirect damage and losses

The basic information required to estimate direct damages and indirect losses must be obtained from reports produced by national and local authorities and other non-governmental organizations that normally operate in the areas affected by the disaster and that participated in the emergency and humanitarian assistance stage. It must be complemented with information obtained by the housing and human settlements specialist during his/her field visit. Media reports can also be useful to the specialist, when duly weighed against field observations.

Information on unit prices can normally be obtained from various sources, such as bulletins issued by the construction sector, documentation of recent bidding on housing projects, material and equipment suppliers' price lists, indexes of changes in prices and wages in commercial, industrial and construction associations, and the printed media. Interviews with construction companies and associations of engineers and architects in the area may prove very useful.

4. Macroeconomic effects

Direct damage and indirect losses in the housing and human settlements sector have an impact on the living conditions of the population and on economic performance. These effects include the following:

- The loss of the contribution to the national economy of income generated directly or indirectly by housing leases (actually paid in or implied) with the corresponding effect on gross domestic product (GDP);
- An increase in construction sector activity;
- Effects on the external sector;
- Effects on the public sector;
- Effects on prices and inflation; and
- Effects on employment and income.

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Each of the aforementioned macroeconomic effects is described in the following sections.

i) Loss of the contribution of housing leases to the economy. Gross domestic product takes into account rents and leases in a country's entire housing sector. This is estimated by multiplying the number of existing dwellings by the lease paid plus the implied lease on dwellings inhabited by their owners. When a disaster causes the destruction of, or significant damage to, the national housing stock, there is a corresponding effect on GDP.

The housing and human settlements sector specialist must cooperate with the macroeconomics specialist to carry out the corresponding estimates for this heading. The loss will be estimated by multiplying the number of dwellings totally destroyed by the average value of their actual or implied leases.

ii) **Increase in construction activity.** After a disaster occurs, activities in the construction sector are stepped up as rehabilitation and reconstruction programmes begin. In the case of major disasters, this may contribute to reactivating the economy or offsetting the fall in growth of other productive activities that might have been negatively affected by the same disaster.

The housing and human settlements specialist and the macroeconomist must jointly analyze the impact of housing sector rehabilitation on the construction sector. This must be based on a realistic analysis of reconstruction programmes and projects, available financing and the construction industry's execution capacity. The housing and human settlements specialist must obtain the rehabilitation and reconstruction plans for the sector from the relevant authorities, revise them and adjust them in accordance with an objective vision of actual domestic execution capacities; then he/she must prepare a realistic execution timetable. This schedule should be shared with the macroeconomics specialist for his/her GDP estimates.

iii) **Effects on the external sector.** Whenever a major disaster occurs, damage to the housing and human settlements sector can have negative repercussions or effects on the external sector of the affected country or region, as the need for additional materials, equipment and machinery will require that they be imported or diverted from the country's normal export flows.

74 If there is no local production of reconstruction materials, equipment and machinery, they will have to be imported from abroad, thus pressuring the country's balance of payments. The housing and human settlements specialist will have to determine, in close cooperation with local authorities, which components of buildings and equipment are not produced by the domestic industry so as to estimate the "imported component" of direct damages. This estimate will be used by the macroeconomics specialist for his/her external sector forecasts.

When the country is an exporter of these types of components, the execution of the reconstruction programme may greatly diminish or eliminate such shipments abroad, thus pressuring external accounts in the form of diminished export revenues.

Housing and other buildings are often insured against different risks, and local insurance companies have reinsurance with foreign companies. Should this be the case, when reinsurance payments are made, they generate a net foreign currency inflow that must be taken into consideration. The housing and human settlements specialist must determine the possible amount of such reinsurance flows and transmits the information to the macroeconomics specialist so that this information may be included in the foreign sector analysis

iv) **Effects on the public sector.** Public finances may be significantly pressured when central or local governments undertake demolition, debris removal and reconstruction work in the housing and human settlements sector.

The most significant expenses in rehabilitation and reconstruction tasks for the sector can be projected based on the estimated cost of the respective projects. An estimate can be made of the shortfall in tax receipts expected as the destruction of housing and other buildings pares tax collection. This can be estimated based on implied rent that will not be received.

The housing and human settlements specialist once again must cooperate closely with the macroeconomics specialist to carry out these estimates.

v) **Effects on prices and inflation.** During the visit to the affected country or region, the housing and human settlements specialist will not normally have enough time to estimate the effect of the disaster on prices of reconstruction inputs. However, speculation and a possible shortage of construction materials and equipment may result in price increases. The specialist must at least obtain qualitative information on the behavior of the supply and prices of these inputs by comparing current prices during his/her visit with those prevailing before the disaster, and on this basis provide a learned opinion as to their possible future evolution.

As in other cases, close cooperation between the housing and human settlements specialist and the macroeconomist will be essential.

vi) **Effects on employment and income.** A disaster may affect the employment and income of the people that work in the sector. Indeed, there can be temporary paralysis of normal construction work during the humanitarian assistance stage, including the indefinite suspension of development projects in the sector. Later, as reconstruction gets underway, construction sector employment is likely to expand and wages may rise in the event of a shortage of labor.

The paralysis that may accompany the emergency phase is generally very short lived, so the field visit may determine its effect to be insignificant. Experience suggests that it is very rare for development projects in this sector to be entirely abandoned in the face of reconstruction work; in fact, reconstruction and development projects are frequently combined. Therefore, the task of determining the impact on employment is normally limited to estimating the number of new jobs that will be required during reconstruction.

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This increase in employment can be estimated based on the annual amount of investment in reconstruction, using factors that relate annual investment to the number of jobs. In this regard, the housing and human settlements specialist must cooperate with national or local authorities to determine these relationships for the special case under consideration, after a reconstruction timetable has been defined.

5. The reconstruction programme

The housing and human settlements sector specialist is often also involved in drafting or recommending changes to reconstruction strategies, plans and programmes, including prevention and mitigation measures.

She or he must identify and describe the characteristics and conditions of housing and its environs that might have determined the form and scale of the damage they sustained. This will make it possible to make general recommendations for reconstruction work.

This will require the description of the most common types of construction of the houses in the affected area and their disaster-related structural or non-structural failure. Equally essential are descriptions of the most commonly used construction materials in the affected area, their quality and behavior during the disaster and their suitability for the most common building typologies. In addition, the location of the houses and the physical characteristics of the environment -such as soil type, geology, topography, etc.- that might have had an influence on the degree of resistance of housing to the natural phenomenon will also have to be described. Such details will make it possible to prepare recommendations on the following relevant aspects of the reconstruction process:

- Technical characteristics of the repair and reconstruction of houses, processes to be applied and the types of locally available or imported materials to be used;
- The location or relocation of houses in accordance with the environment's characteristics, including reference to the need for upgrades when it is not possible to relocate houses away from vulnerable areas;
- Economic and supply issues for reconstruction inputs; and
- Administrative and institutional matters for the execution of reconstruction works such as community participation, available technical support, personnel training, inter-institutional coordination and the like.

76 It will also be necessary to identify and briefly describe those technical cooperation projects –international or national– that might be required to fully develop the items described above in order to support reconstruction.

Any available information on rehabilitation and reconstruction project lists must then be collected, clearly indicating the amounts of required investments and possible sources of financing (international or through internal resources, public or private).

The housing and human settlements specialist must develop a timetable of reconstruction works and their corresponding financial requirements to be able to prepare one or more hypotheses on the amounts and periods in which reconstruction can be carried out, estimating the possible effects on public finances and the institutional capacity to carry them out. To do this, the following aspects must be taken into account:

- The availability of financial resources for reconstruction and the time periods required for their negotiation, allocation and disbursement;
- The institutional and organizational capacity of institutions that will be responsible for leading and executing reconstruction, taking into account the role the public and private sectors and civil society will play therein;
- The capacity of the construction sector to face the challenge of reconstruction, taking into account the scale of disaster damage –to housing and other affected sectors– as well as the volume and value of the sector's output (during the five preceding years, for example), while bearing in mind that reconstruction will generally demand an additional effort on top of normal construction activities;
- The supply of inputs for reconstruction –in terms of human resources, materials and equipment– including any imports that might be required;

- The time periods required for the design, planning and organization activities for reconstruction; and
- Aspects related to climatic conditions and to the return to normalcy after the disaster. For example, the onset and duration of the rainy season or the time required for floodwaters to recede might prevent or hinder reconstruction work.

The housing and human settlements specialist will have to obtain all information possible on the above-mentioned items from public and private - sector organizations, and add his/her own observations derived from the field visits undertaken during the assessment mission. This will make it possible to prepare a timetable of the number of dwellings and the amount of investments that will be possible in each succeeding year; this schedule can be used for analyzing both reconstruction and its macroeconomic impact.

III. EDUCATION AND CULTURE

A. INTRODUCTION

1. General comments

This chapter describes how to assess disaster damage and losses to the education and culture sector's infrastructure, equipment and general functioning. The infrastructure considered here includes all premises used for school or adult education (classrooms, laboratories, workshops, etc.) and their auxiliary installations, such as sanitary services, general services and administration, storerooms, sports areas and installations and libraries. Culture includes all buildings considered to form part of cultural and historical heritage, including assets formally declared to be part of heritage, museums, archaeological sites, archives, libraries, churches, houses located within historic centers and houses of culture. We do not include under this heading buildings that form an integral part of other productive or social sectors, such as libraries and training classrooms located in hospitals or in manufacturing industry.

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In Latin America and the Caribbean, both public and private sectors attend to these sectors, with the relative weight of one and the other varying from one country to another. In many rural or low-income urban areas, schools also discharge other functions by serving as centers for community and cultural activities. In other cases, the relationship is inverted, and churches, community centers and so forth are used for educational activities.

Schools are often used to temporarily house disaster victims, which can cause both a temporary interruption of the school cycle and damage from the use of the installations in overcrowded conditions.

Undoubtedly, the reconstruction of the education and culture sectors after a disaster will not be so significant when compared to –for example– the housing or transportation sectors. Nevertheless, delays in restoring normal operations in the education and culture sector after a disaster can have very important repercussions and even psychological effects on affected families.

2. Assessment procedure

The procedure to be followed to assess damage to education and culture is very similar to the one just described for the housing and human settlements sector. Indeed, the specialist in education and culture must work closely with the housing and human settlements specialist to ensure there is no duplication of estimates, especially in regard to houses and buildings of historic value.

The education and culture specialist must produce a summarized table of the damage and losses sustained in his/her area. The table should indicate the amount of direct and indirect effects, break them down by type of property (private and public) and educational level (primary, secondary and university) and show their spatial distribution within the geopolitical unit previously agreed on with other members of the assessment team. The following table shows the type of result the sector specialist must produce at the end of the assessment.

Table 2
DAMAGES ON EDUCATION AND CULTURE
(Millions of dollars)

Item	Damage			Sector		Cost of reconstruction	Imported component
	Total	Direct	Indirect	Private	Public		
Total							
Public schools							
National University							
Private schools							
Sports centers							
Cultural heritage							
Houses of culture							
Town halls							
Houses in historic centers							

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Likewise, the specialist in education and culture must estimate the effects of his/her area on the main macroeconomic variables -the external sector, public finances, etc.- to assist the macroeconomics specialist. He/she will also have to interact with the employment specialist to jointly determine the impact of the disaster on education and culture. Likewise, he/she will have to work in close cooperation with the gender specialist to estimate the differential impact of the disaster in the sector on women, including -among other factors- the increase in women's reproductive work when school activities are suspended.

A usual procedure to carry out the required work would include and follow the sequence of actions described below:

- Definition of the affected area for the sector, based on the standard procedure described in the first chapter in this section of the Handbook;
- Determination of the spatial distribution of total damage and losses;
- Assessment of the conditions prevailing before the disaster occurred;
- Identification of direct effects;
- Quantification of direct damage;

- Valuation of direct damage;
- Identification of indirect losses;
- Estimation of indirect losses;
- Valuation of indirect losses;
- Determination of the geographic or spatial distribution of total damage and losses;
- Assessment of macroeconomic effects;
- Assessment of the impact on employment;
- Assessment of the differential impact on women;
- Collection of information that the sector's authorities might already have available on reconstruction strategy, plans and projects as well as their execution timetable and possible budgets;
- Identification of items or areas within the sector that might need priority support or attention during reconstruction and their possible financial requirements; and
- Support in the formulation of the final reconstruction strategy, plans and projects, as an input for the affected government.

3. Information requirements

The specialist in education and culture must gather information that will enable him/her to develop a baseline for the sector in order to assess the impact of the disaster. The information listed below is the minimum that should be obtained.

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Educational premises:

- Number of educational premises existing in the affected area, classified into urban and rural, publicly and privately owned and educational level (primary, secondary or middle, technical and vocational, university).
- Number of classrooms and students –total or, for example, per morning, afternoon and evening shift– for each educational premise;
- Quality of the building of the premises, based on –for example– the type of construction materials used (adobe, wood, brick, concrete, etc.), the average age of the construction and its degree of maintenance;
- Furnishings and equipment typical of educational centers in accordance with previously defined categories; and
- Unit building, furniture and equipment costs.

Cultural heritage buildings:

- Number and characteristics of public historic heritage assets –in other words, historic assets declared to be State property– broken down into the categories of world heritage, heritage buildings, museums, archaeological sites, movable goods, archives or documentary collections;
- Number and characteristics of private historical heritage assets –whether individually or institutionally owned– broken down into heritage churches, houses located in historic centers, libraries and collections located in foundations, libraries and churches;

- Non-heritage public cultural infrastructure –in other words, non-historical assets that are State owned and under official cultural programmes– broken down into cultural spaces, libraries, recreational parks, cultural centers in indigenous communities and artisans communities;
- Quality of construction of the above premises, based on –for example– the type of construction materials used (adobe, wood, brick, concrete, etc.), the age of the construction and its degree of maintenance;
- Furnishings and equipment typical of heritage centers in accordance with previously defined categories; and
- Unit costs of building, furniture and equipment.

As in the case of housing and human settlements, construction, furniture and equipment unit costs must be determined at current market prices with the later application of depreciation coefficients to estimate the current value of the lost or damaged assets, as described in the section on direct costs in Section One of this Handbook. Costs must be obtained in the local currency of the affected country, and later converted into dollars based on an official exchange rate defined in cooperation with the country's financial authorities, for the time of the disaster.

4. Sources of information

As in other cases, local, national and international information sources in the education and culture sector must be used.

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The normal local and national sources include:

- Ministries of education and culture;
- Public - sector institutions entrusted with building and maintaining educational and cultural premises;
- Public institutions that are entrusted with coordination of university and adult education;
- Religious bodies and private foundations that manage and operate educational and cultural centers;
- Insurance companies, especially for the case of museums, libraries and archives; and
- Censuses of the educational and cultural sector.

The main international sources for the sector are the United Nations Education, Science and Culture Organization (UNESCO) and the Organization of American States (OAS). Both maintain records and issue periodic publications on the development of the education and cultural heritage of the Latin America and Caribbean countries. The Economic Commission for Latin America and the Caribbean (ECLAC) also publishes information on the sector, most notably in its Social Panorama.

B. QUANTIFICATION OF DAMAGE AND LOSSES

1. Direct damage

a) General comments

As mentioned in Section One of this Handbook, direct damage refers exclusively to losses of capital or assets. In the education and culture sector, direct damage refers to the destruction of, or damage to, buildings, furniture and equipment, and materials, works or volumes of a cultural nature stored in heritage buildings that may have been affected by a disaster.

Because of the similarity to the housing and human settlements sectors, there is no need to repeat the methodology for damage assessment. The specialist in education and culture should refer to the corresponding chapter to obtain detailed information.

b) Classification of buildings

Unlike in the housing sector, a classification or typology of education and culture sector buildings is not a simple task. An exception might be public school-based education centers, especially those built in recent years under development programmes for the sector. Other educational establishments, especially cultural establishments, always have non-standard construction designs and qualities. Educational establishments are often converted residences or buildings originally intended for other uses that have been adapted as teaching premises. Heritage buildings in turn, are not only highly diverse, but in many cases were built many years ago, even as far back as the Colonial era.

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i) Teaching premises. Some typologies of school premises should be established in order to facilitate the education and culture specialist's work, on the basis of -for example- educational level, type of construction materials used, state of preservation or the age of the building. This implies that teaching premises of the same educational level have similar spaces as regards areas for teaching, other purposes and recreation. The type of materials used in the construction will enable an estimation of the buildings' unit costs of construction, whereas the degree of preservation and age of the building will assist in determining their depreciated value and in differentiating between damage caused by the disaster itself and damage sustained due to the lack of proper maintenance.

The space standards below are not always strictly enforced, depending on the educational level and location (urban or rural) of the educational establishment. As regards spaces and equipment used for adult and university education, the range is so broad that it is impossible to present average values that would have widespread application. Therefore, the education and culture specialist will have to carry out assessments on a case-by-case basis and define typologies on each occasion, based on his/her observations in the field. Notwithstanding, the standards presented here might provide a basis for the specialist's work in the field.

RANGE OF SPACE STANDARDS FOR SCHOOL PREMISES

Standards governing the construction and operation of school premises throughout the region of Latin America and the Caribbean vary widely. However, their ranges based on the type or use of educational premises can be given, as follows (figures indicate square meters per student):

Classrooms for primary and secondary education

Total surface area of construction	6.0 (Argentina) to 1.2 (Paraguay)
Surface area of individual classrooms	1.5 (Uruguay and Peru) to 0.9 (Guyana and Haiti)

Other school installations

Administrative buildings	0.85 (Argentina) to 0.05 (Bolivia)
Laboratories	3.80 (Ecuador) to 1.20 (Dominican Republic)
Technical and manual workshops	5.00 (Ecuador) to 1.20 (Uruguay)
Art workshops	6.00 (Paraguay) to 1.50 (Uruguay and Peru)
Industrial workshops	9.00 (Guyana) to 4.50 (Guatemala)
Libraries	4.32 (Brazil) to 0.15 (Bolivia)
Music rooms	2.70 (Paraguay) to 1.20 (Argentina).

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ii) **Cultural heritage buildings.** In this case, infrastructure and equipment follow no standards because the buildings vary widely in origin and construction. However, these buildings could be classified along the following typologies:

Public historic heritage buildings, including historic assets declared as such that are the property of the state:

- World heritage, world cultural assets registered in UNESCO's list of World Cultural and Natural Heritage;
- Heritage buildings or declared historic buildings, with their equipment and collections;
- Museums;
- Archaeological sites;
- Moveable goods, such as state-owned collections of historic value that might be located in buildings other than museums; and
- Archives and collections of documents.

Private historic heritage buildings, whether owned individually or by foundations:

- Churches registered as historical heritage through legislative decrees or executive orders;
- Dwellings located in historic centers, including buildings of historical value (used as dwellings or as dwellings and businesses) located within sections deemed historical heritage; and
- Libraries and collections, including private moveable goods located in foundations, libraries, churches, etc.

Non-heritage public cultural infrastructure, referring to State-owned non-historical goods operated under official cultural programmes:

- Cultural spaces, including houses of culture, public libraries and non-heritage theatres;
- Libraries and their equipment;
- Recreational parks, including zoos;
- Cultural centers in indigenous communities; and
- Artisan and crafts communities.

iii) Sports facilities. This is another instance in which there are no patterns, as each facility is unique in its characteristics, design and construction materials. Assets that may be damaged include gymnasiums, stadiums and other, smaller facilities.

c) Components of buildings that are prone to damage

Although the education and culture sector shares many similarities with the housing and human settlements sector, it has special characteristics that should be noted. In any case, the education and culture specialist should refer to the corresponding housing sector chapter in order to complement the assessment of damage to or destruction of his/her sector.

i) Buildings, furnishings and equipment. In the education and culture sector, "furnishings" is meant to include all instruments, utensils and equipment used in education and culture functions (for example laboratory and manual workshop equipment, sports gear, etc.), or that may be necessary to process or use works contained in the buildings (such as microfilm readers, computers, projectors, etc.) that are normally individually itemized in inventories.

On the contrary, "equipment" refers to installations that are part of the building itself, such as elevators, security equipment, air conditioning, internal communication systems, and so forth.

ii) Stocks, works and collections. Buildings used for education normally have stocks of school materials (paper, books, chemicals, etc.) required for the undertaking of their respective activities. Their whose value can be sufficiently high to warrant individual assessment.

Inventories of works and collections deposited in a given institution must also be included under this heading. This must include books in libraries, religious and art works, samples or pieces in museum collections, the documentation in archives, and so forth.

Educational materials may be easily replaced; ascertaining their value is a straightforward matter. Works of a cultural, historic and religious nature found in libraries, museums, archives and churches must be identified almost individually. The latter can be difficult (or impossible) to repair or replace when they are unique or irreplaceable works. It is difficult to carry out valuations of objects whose value is subjective or that are not openly exchanged in the marketplace, as in the case of works of art or those that have a historical value.

d) Quantification of damage

Once again, reference must be made to the indications included in the housing and human settlements sector to quantify damage in the education and culture sector, because the valuation and quantification criteria contained therein are also applicable in this case. It is directly applicable to both educational - establishments and non-heritage cultural infrastructure. However, the cultural heritage subsector is a special case, and its particular headings are described below.

i) **Heritage buildings.** These will have to be treated individually because they are highly heterogeneous, and their direct repair or replacement cost will be estimated on an individual basis. When only repairs are needed, specialists in the field will have to be consulted to estimate restoration costs.

Valuating completely destroyed historical centers requires average bids made just prior to the disaster to purchase the dwellings and buildings, bearing in mind that there are land-use controls and that therefore no speculation would be involved. It is assumed that the bid price represents the cultural value and condition of the buildings within said historical centers.

Furnishings and equipment costs must be estimated following the same criteria as for the housing and human settlements sector, duly adapted for application to each cultural building.

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ii) **Movable goods, archives and other items.** The recovery costs of works of art, collections and objects of a historical value must be estimated in consultation with a specialist in the field, taking into consideration the type of good (paintings, sculptures, decorative objects, religious images, etc.), its origin and antiquity, and the degree of damage sustained. In the case of archives, a recovery alternative would be to estimate the cost of microfilming to at least keep the information available for public use.

Experts will have to be consulted in order to estimate the value of totally destroyed goods. Insurance companies can often provide the required information, since these goods are often insured.

2. Indirect damage

a) General comments

Direct damage to assets of the education and culture sector cause indirect losses in the future, while the affected goods are being repaired or replaced. These losses include the following items:

- The costs of repair or rehabilitation of educational and sports premises that were used temporarily to house refugees;
- The costs of demolition and debris removal, after the emergency stage and before reconstruction;
- The costs of temporarily leasing premises to provide educational or cultural services that might be incurred during repair and reconstruction of infrastructure;

- The costs of reducing vulnerability in the sector's buildings;
- The costs of buying land and installing basic services to relocate buildings in less vulnerable or invulnerable areas;
- Income that will not be received as student fees while school premises are under repair or reconstruction;
- Income that will not be received from heritage establishments and from sports facilities during the repair or reconstruction period; and
- The increase in women's reproductive work because of the suspension of school activities. This figure should be included in the estimate of the differential impact of the disaster on women.

b) Estimation of indirect effects

i) Damage due to the temporary use of educational, sports and cultural premises as shelters. Schools, stadiums and churches are often used to temporarily house refugees during disasters. This leads to damage to their infrastructure, which is not designed for continuous use by a large number of people. Therefore, the cost to repair these installations must be estimated as indirect damage. Repairs are often needed to sanitary services, walls must be repainted and furniture and other similar items must be repaired.

ii) Demolition and removal of debris. To repair or rebuild any kind of building, its damaged or destroyed parts must be demolished, and the debris removed and disposed of. Depending on the type of construction involved, these costs may amount to significant proportions of the total cost of the building.

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These demolition and debris removal costs are different from costs incurred during the emergency stage to locate and rescue people trapped inside buildings. The latter are to be included under emergency stage expenditures.

In light of the variety of materials used and the diverse location of buildings in the education and culture sector, their demolition and debris removal costs are highly varied. Therefore, they are often estimated based on the volume of material to be removed and the unit cost of removal and transportation for each establishment in the sector. Another way of proceeding is to adopt a percentage of the total replacement cost of the affected good, which –as experience shows– may range from 10 to 25%.

iii) Temporary leases. Given the need to continue ensuring the provision of services –in educational, cultural, sporting and religious buildings that have been damaged or destroyed– it is usual to lease other premises while the original building is being repaired or rebuilt. Such costs must be estimated based on prevailing rents in the market at the time after the disaster and projected throughout the estimated repair or reconstruction period.

The cost of transporting all furniture and equipment required to provide the educational and cultural services to and from the leased premises must also be included under this heading.

iv) **Vulnerability reduction.** Costs to reinforce buildings in order to prevent further damage by similar future events must be taken into account under this heading. These may include reinforcement of structures, stabilization of soil that has been affected by mudslides or land settling and flood protection works. Likewise, protection systems might have to be established for moveable goods and objects of cultural value that may be located within the buildings, in addition to the establishment of early warning and evacuation systems in schools.

v) **Relocation of buildings.** Costs to relocate buildings exposed to the action of extreme natural phenomena into safer places must be estimated, provided there exists reasonable evidence that relocation will actually be undertaken.

The following costs should be included:

- The value of the land where the new building will be located;
- The cost of providing water, sanitation, power, telecommunications and other services when not available on the plot chosen; and
- The cost of transporting furnishings and cultural goods to the new location.

vi) **Loss of income.** Especially in the culture sector, but in education and sports as well, there will be losses of future income throughout the repair and reconstruction period resulting from damage to, or destruction of, infrastructure and goods. Likewise, commercial and tourism activities often cease due to damage to or the loss of heritage property, resulting in a reduction in or loss of income for the affected establishment or community.

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The education and culture specialist must estimate the income that will not be received, based on what used to be received before the disaster and the estimated rehabilitation or reconstruction period. In addition, the education and culture specialist must cooperate with the productive sector specialists to estimate –and not duplicate– reductions in commercial and tourism income (local or regional fairs, etc.) that may occur in the future due to the damage to or lack of cultural buildings and property.

vii) **The differential impact on women.** When educational establishments are temporarily used as shelters for refugees, classes are normally suspended and women must face an increased amount of reproductive work to look after children of school age at home. Although this item is not considered in national accounts –as mentioned in the appropriate chapter on the differential impact of disasters on women– the education and culture specialist must cooperate with the gender-related specialist to estimate this increase in women's reproductive work, providing the estimated duration of the period for which the school year will be suspended.

In addition, the education and culture specialist must estimate, in cooperation with the gender and employment specialists, the temporary loss of employment and income for women in this sector, since it usually employs a relatively high proportion of women.

3. Macroeconomic effects

a) General comments

Damage to or the destruction of buildings in the education and culture sector caused by disasters will produce effects on macroeconomic performance and living conditions in the affected country or region. These effects will occur along a period of variable duration after the disaster.

A list of these macroeconomic effects is shown below:

- The loss of the sector's contribution to the development growth rate of the national or local economy;
- Effects on employment;
- Effects on the external sector;
- Effects on public finances; and
- Effects on prices and inflation.

b) Estimations of macroeconomic effects

The education and culture specialist must cooperate with the macroeconomics specialist to estimate the macroeconomic effects arising from the sector.

i) Loss of contribution to development growth rate. Institutions in the education and culture sector generate income that is calculated within the personal services sector in the national accounts system.

To estimate this loss, it is first necessary to estimate the "production" of such institutions while differentiating between private for-profit, private non-profit, and public - sector institutions. The production of for-profit entities can be estimated by using the same criteria applied to industrial sector companies, while that of non-profit entities can be carried out indirectly, by measuring loss as a function of inputs. The quantities or volumes of imports –both intermediary and primary– will have to be estimated and multiplied by their estimated average unit price and by the period of time the cessation of services is estimated to last.

The impact of private education losses on the GDP growth rate may be estimated by combining the non - received average fees and the time period over which classes were suspended, as indicated under the heading of indirect effects. The result must be adjusted by the ratio of value added over total value for the sector –which usually ranges from 50 to 75 per cent– in the national accounts for the affected country. As an alternative, use could be made of the ratio of value added to gross income, derived from school accounting.

The macroeconomic impact of losses in public education is usually non - existent or extremely low, as its contribution to GDP is measured through wages and salaries earned by teachers and other sector employees of the sector, who generally continue to work and be paid during disaster situations, even if at alternative locations.

In any case, care must be taken not to calculate temporary interruptions of service in normal working timetables when these are to be made up whether by extending the school year or implementing double shifts on the same premises – unless such measures imply greater disbursements for the year.

ii) **Effects on employment.** A disaster may lead to changes in the sector's employment rate by rendering personnel who work in the affected institutions unemployed for relatively long periods. However, in many public - sector cases, as previously indicated, personnel collect their wages continuously throughout the whole year, something the education and culture specialist must take into account when making his/her estimates. In any case, the number of employment positions lost temporarily is to be estimated, and the sector specialist must cooperate closely with the employment specialist.

iii) **Effects on the external sector.** The repair or reconstruction of education, sports and culture sector facilities can have an effect on the affected country's imports and exports. This could be due to the situations described below.

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- When construction materials, machinery and equipment are not produced domestically, they will have to be imported from abroad, with the subsequent effect on the balance of payments. Estimation of this item must be carried out in the same fashion as described in the housing and human settlements sector; that is, estimating the proportion of imported elements and costs in reconstruction.
- The affected country might export materials, machinery and equipment whose production might be redirected to reconstruction, thereby resulting in a shortfall in exports and a subsequent effect on the balance of payments. To estimate this item, the education and culture specialist must cooperate with the housing and human settlements specialist and jointly analyze the installed capacity of the construction sector.
- As a result of insurance for damage to or destruction of buildings and goods in the sector, that portion of the insured amount that is reinsured by companies abroad must be taken into account as an increase in foreign currency income and introduced in the balance of payments. This is especially important in the case of works of a high historic and cultural value. To estimate this item, the specialist must consult with local insurance companies.
- Financing for reconstruction programmes and projects normally involves foreign-currency income throughout the reconstruction period. The duration of said period and a tentative scheduling of reconstruction and its external financing must be defined with local authorities, and the effects on the balance of payments, estimated on that basis. The education and culture specialist must cooperate closely with the macroeconomics specialist in these estimates.

iv) **Effects on the public sector.** The destruction of, or damage to, the sector's facilities and their repair or reconstruction can significantly affect public finances, especially under the following two items.

- Lower revenue due to the reduction in tax collection or transfers in the sector's damaged or destroyed buildings, which can be estimated based on the reduction in the income of each private institution affected and its income-tax rate;
- Greater public sector spending and investment needed for rehabilitation and reconstruction, which are estimated based on project execution and financing schedules, as indicated in the heading on effects, above.

v) Effects on prices and inflation. If there is significant damage and destruction in the sector and shortages arise in materials, machinery and equipment for reconstruction, the prices of such inputs might rise. This is true for all sectors of the national economy.

The specialist in education and culture must cooperate closely with the housing and settlements and macroeconomics specialists to deal with this issue, and must at least provide inputs –even if only quantitative– so that the latter can carry out a complete analysis of the situation.

APPENDIX V EXAMPLE OF CALCULATING DAMAGE TO THE EDUCATION AND CULTURE SECTOR

The information available on the earthquakes that affected El Salvador in January and February 2001 is used to illustrate how to calculate the damage and effects caused by a disaster in the case of the education and culture sector.

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1. Direct damage

Direct damage to the education and culture sector was estimated based on the field observations of mission specialists and prior surveys by the sector's local authorities.

a) Education

It was determined that the first earthquake damaged or destroyed a total of 1 367 educational centers, including various National University buildings, in addition to 34 private - sector premises. With the second earthquake, 219 buildings that had already been affected by the previous event were further damaged or destroyed, and an additional 150 public sector and 27 private - sector educational premises were affected, raising the total figure for educational premises affected to 1 516.

The average unit price for the repair or construction of each kind of building was determined, differentiating between buildings in the urban and rural sectors, and between educational level; that is, primary, secondary, technical and vocational, and university. These figures, taken together with the average surface areas of construction for each type of building, allowed total direct damage to education to be estimated at 63.9 million dollars.

In the case of sports facilities, it was determined that there was minor damage to the infrastructure of three public - sector stadiums administered by the National Sports Institute, as well as to some privately - owned stadiums. An estimate was made of the cost of repairing these structures, with the total amounting to 1.2 million dollars.

b) Culture

The earthquakes negatively affected the country's cultural heritage. There was damage to numerous public historic heritage installations: cultural goods, 22 heritage buildings, two museums, an archaeological site, furnishings and archives. Damage was also recorded in the case of private historic heritage (more than 100 churches, 5,120 dwellings located in historic centers, libraries and the collections of two foundations), in addition to cultural locations such as 145 urban culture centers, three libraries, various theatres, three recreational parks, 39 cultural centers in indigenous communities and 40 craft communities.

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A detailed and individualized estimate of each heritage center had to be carried out in cooperation with government authorities to determine the cost of repair or reconstruction. For public historic heritage sites, an estimate was made of the costs of restoration and replacement of objects, collections, furnishings and equipment, as well as the repair and reinforcement of buildings. For private historic heritage, the costs of repairing and rebuilding churches had to be estimated, based on figures available in the country for certain rescue projects. The estimate of the costs of replacing dwellings located in historic centers was based on purchase bids available before the disaster in controlled-use sites, together with estimates of the value of the furnishings and equipment of the dwellings; when dwellings had been partially damaged, the costs of repair were estimated. As regards non-heritage cultural infrastructure, repair and reconstruction costs were estimated based on figures available for contemporary buildings of similar characteristics. In the case of craft communities, in addition to the cost of the repair or reconstruction of infrastructure, the value of stocks of goods stored by members, 75% of whom are women, had to be estimated. The cost of repairing damage to cultural centers located in indigenous communities was estimated based on the costs of recent construction in similar centers.

The total amount of direct damage to the culture subsector was estimated at 125.2 million dollars.

2. Indirect effects

a) Education

Few educational centers were used as temporary shelters for victims. Nevertheless, the start of the school year had to be postponed until premises were available, either after repairs were completed or when temporary or leased facilities could be made available. In addition, authorities decided to postpone the start of students' vacations to match the delay in the start of the school year, ensuring there would be no loss in the quality of education. The indirect damage estimated in this case was for the provision of temporary or provisional classrooms, amounting to 19.2 million dollars.

Because of the minor damage to certain public and private sports installations, certain events had to be suspended, causing a loss of income that also had to be estimated, worth 0.7 million dollars.

b) Culture

In the case of cultural heritage, income not received during the period needed to repair or reconstruct historic buildings, both public and private, was estimated, along with the temporary leasing of other premises to house some of their activities. In the case of dwellings located in affected historic centers, the estimated cost of leasing equivalent units was, calculated at 5% of direct cost. The total amount of indirect effects was estimated at 0.2 million dollars.

In addition, the reduction in the income of craft community centers during the period needed to rehabilitate and reconstruct infrastructure, as well as that of fairs that are carried out around historic or religious buildings that were damaged or destroyed, was estimated. However, these items were taken into account in the trade and services sectors to avoid duplication when determining the total amount of damage in the country.

3. Summary of damage

The total amount of damage caused by the earthquakes of January and February 2001 in El Salvador in the education and culture sector was estimated at 57.3 million dollars: 40.9 million dollars in direct damage to heritage and 16.4 million dollars in indirect effects stemming from reduced income and increased spending to provide services. The analysis indicates that 51% of total damage was to the public sector (29.4 million dollars), while the remaining 49% (27.9 million dollars) belonged to the private sector.

IV. THE HEALTH SECTOR

A. INTRODUCTION

1. General Comments

All disasters have an impact on the health sector, whether due to the need to protect the population's health during emergency situations and disasters, evacuate and rescue victims and modify health-care models or programmes in the medium and long term, or because of damages caused to the infrastructure of the health-care services network. This impact translates not only into immediate needs, but also into long-term effects.

Understanding and assessing these effects requires the availability of information that allows one to determine, in the time available for the assessment, the scope of damage to the sector's different components and functions. In the absence of such information, the assessment must proceed via spot studies or projections to measure the time and requirements for recovery. The collection and analysis of information and, more generally, the implementation of health information systems, is an essential component of disaster preparation. The availability and quality of the health information are very important, because they form the basis for understanding the fundamentals of health policy and thus provide the opportunity to undertake a review of the health-care services network, with an eye to rationalizing resources and modernizing the sector.

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Disasters can be considered a problem for public health for several reasons:

- They can cause an unexpected number of deaths, injuries or illnesses in the affected community, thereby exceeding the therapeutic capacity of the local health-care services and forcing authorities to reorganize the sector or to solicit outside help;
- They can destroy local health infrastructure such as hospitals, health-care centers, laboratories and the like, which will thus be unable to respond to the emergency. Disasters can also alter the provision of routine health-care services and preventative activities, with subsequent long-term consequences in terms of increased morbidity and mortality;
- Some disasters can have adverse effects on the environment and the population by increasing the potential risk of transmissible diseases and environmental dangers that increase morbidity and premature deaths and could lower the quality of life in the future;
- They can affect the mental health and the psychological and social behavior of the affected communities. Generalized panic, paralyzing trauma and antisocial behavior rarely occur after big disasters, and the survivors quickly recover from the initial shock. However, anxiety, neurosis and depression can arise following both sudden and slowly forming emergencies;
- Some disasters can cause food shortages, with severe nutritional consequences such as a specific deficit of micronutrients (vitamin deficiencies); and

- They can cause broad movements of the population –whether spontaneous or organized– often to areas where the health-care services cannot meet the new situation, with a consequent increase in morbidity and mortality. The displacement of large population groups can also increase the risk of outbreaks of transmissible diseases in the displaced and host communities, where the large groups of displaced persons may be housed in and share unhealthy conditions or contaminated water.

After the disaster, the sector must take on three essential tasks: the rescue, treatment and subsequent care of primary trauma victims who have suffered the direct effects of the disaster; the prevention of the appearance or propagation of effects that are harmful from the perspective of public health; and the speedy recovery of the affected health-care facilities. Any expense that corresponds to the rescue, treatment and subsequent care of primary trauma victims that has not been taken into account in the emergency stage or in the corresponding section of the affected population must be accounted for within the assessment of the corresponding effects on the health sector, as discussed in the present chapter.

Given that the health sector's mission is to prevent the propagation of disaster-related effects that could endanger the public health, unfounded rumors and the speed with which massive international efforts in medical aid are mobilized to the most distant areas have contributed, in part, to the erroneous idea that disasters are almost inevitably accompanied by the outbreak of epidemics transmitted by contaminated water, vectors or direct contact. In fact, experience confirms that there is usually no immediate risk of epidemic outbreaks due to causes attributable to a disaster. After a period of time has passed, the implementation of normal surveillance methods for detecting epidemics or the application of a situation-specific protocol of surveillance makes it possible to identify and control the risk of transmissible diseases and prevent any potential epidemic outbreak. Experience gained with all kinds of disasters over the last ten years confirms that it is not necessary to undertake massive vaccination campaigns.

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Recent experience thus shows that the swift mobilization of communities, national resources and international aid facilitates the treatment of the wounded –including the most serious cases– within a short time, thereby reducing the disaster's impact in terms of the length of the “crisis” in the health sector. Consequently, reconstruction issues will be addressed much more quickly and effectively.

2. Assessment procedure

Like the other specialists participating on the assessment mission, the one in charge of the health sector should be notified of his or her participation on the mission two or three weeks in advance. The field mission should last one to two weeks. It is therefore recommended that in the period leading up to the visit, the health specialist should collect all the available information on the sector, both at the national level and at the level of the affected region. Likewise, it is advisable for the specialist to prepare in advance a list of people and institutions with whom contact must be established in the field.

At the end of the assessment mission, the specialist will be expected to present a table summarizing the effects on the health sector. The information should be broken down not only by geographical area, in particular at the level of the country's administrative units (the same units used for all the sectors), but also by public and private sector and by the amount of direct and indirect damage (see Table 1, which presents a model of the kind of information to obtain).

The health specialist should also provide the macroeconomics specialist with any pieces of information that facilitate an estimation of the health sector's effects on the main macroeconomic variables, especially public finances. It is also important to work in close coordination with the specialists in the other sectors to assess the repercussions of the disaster, particularly on the employment sector. With regard to the issue of gender, the health specialist must take into account that the sector employs mostly women and that disasters have a greater impact on women's health.

Table 1

THE IMPACT OF A DISASTER ON THE HEALTH SECTOR
(Thousands of dollars)

Component	Damage			Sector		Effect on the balance of payments*
	Total	Direct	Indirect	Public	Private	
Infrastructure¹ Health ministry Social security Private						
Equipment and furniture² Health ministry Social security Private						
Medications Health ministry Social security Private						
Unforeseen expenses and income Emergency treatment Income not received Treatment not given Increased costs Increased expenditures in medications Epidemiological surveillance Vector control Community education Psycho-social rehabilitation						
TOTAL						

1 Specify the name of the affected infrastructure, if relevant, and the severity of the damage.

2 Identify any equipment and furniture that require specific quantification due to their value.

Table 2

THE IMPACT OF A DISASTER ON THE HEALTH SECTOR, BY AFFECTED REGION
(Thousands of dollars)

Component	Region			TOTAL
	1	2	3	
Health ministry³ Infrastructure Equipment and furniture Medications				
Social security Infrastructure Equipment and furniture Medications				
Subtotal, public sector Private Infrastructure Equipment and furniture Medications				
Subtotal, private sector Unforeseen expenses and income Emergency treatment Income not received Treatment not given Increased costs Increased expenditures in medications Epidemiological surveillance Vector control Community education Psycho-social rehabilitation				
TOTAL				

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The assessment process might develop through the following stages:

- Determination of the geographical area affected by the disaster, as well as the disaster's main immediate effects;
- Analysis of the sector's operation and policy before the disaster, based on existing documents;

³ Specify the name of the affected infrastructure, if relevant, and the severity of the damage, as well as any lost equipment and inputs, so as to facilitate a specific quantification.

- Analysis of the political and socio-economic implications of the disaster's effects on the sector;
- Field assessment of direct damage and effects to validate or modify the information provided by the sector's authorities;
- Quantification of the direct effects;
- Estimation and valuation of the indirect effects;
- Assessment of the macroeconomic effects;
- Estimation of the effects induced on other sectors, in particular on employment and women;
- Gathering of any available information concerning the strategy, plans and projects that may be under consideration, as well as the support and reconstruction resources that are, or may be, made available to the sector; and
- Cooperation in formulating the strategies, plans and projects for the reconstruction and revitalizing of the sector.

3. Information requirements

To assess the disaster's impact and effects on the sector, it is important to analyze the available administrative, economic, social and epidemiological information for the period before the disaster in the affected region and/or country.

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This report should, at the very least, contain the following information:

- The socio-demographic situation and the status of the main epidemiological indicators, including the morbidity rate and incidence of different diseases that are relevant to the type of disaster in question;
- A description of the characteristics and location of existing health-care facilities;
- The existing human resources, equipment and medical supplies in the health sector and its facilities;
- The sector's management, the way in which it is financed and its financial resources;
- The health service coverage provided by each of the different institutions; and
- The cost of the services supplied, including the cost of a doctor's visit, daily hospital room charges and average wages, among others.

4. Sources of information

Sources of information vary widely in type and origin. No source should be ruled out when it comes to obtaining information that might help measure the impacts and assess the direct and indirect effects on the sector.

It is important to make use of existing information, including available publications, pertinent historical material and data on the situation prior to the emergency. It is also advantageous to talk with appropriate, well-informed individuals, including donors, personnel in humanitarian organizations and in national public administration, local specialists, community leaders of both sexes, the elderly, health-care workers, teachers, businesspeople and so forth. Group discussions with members of the affected population can provide useful information on practices and beliefs. Other sources of information include early warning systems and vulnerability assessments, as well as national and regional plans for preparing in case of disaster.

One of the main sources of information will necessarily be the government agencies in charge—in this case, the ministry of health and social security—as they can provide statistical and budgetary information on the sector's resources and activities. Especially useful are annual or periodic budget documents, the inventories of relevant institutions (which contain details on their personnel and materials), periodic statistical publications, reports on health structures and bulletins on the epidemiological situation.

The different services of the health and social security ministry can similarly provide information on current programmes, international aid and any reform plans and projects being developed. Apart from the health ministry, the ministry in charge of coordinating foreign aid and cooperation in the country can supply useful information on the aid resources being channeled into the sector.

The pharmaceuticals industry and the government agency in charge of its regulation generally make available useful information on the medicinal drugs market.

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Information on the population and its main socio-demographic characteristics can be requested from the national institutes or agencies in charge of producing official statistics. More detailed or specific information can be obtained from decentralized agencies, municipalities and professional associations.

Private institutions are another important source of information, as they can supply a detailed inventory of the private sector's infrastructure and human and financial resources, information on the costs of different services rendered, frequency rates for medical visits to private hospitals, private sector development forecasts and so on. Similarly, training bodies and professional medical and paramedical associations are important sources for verifying medical demographic information.

Information published by international agencies that provide specific support to the sector should generally be taken into consideration. Examples include the (regular) statistical publications of the PAHO/WHO, the report on "Health Conditions in America", the UNICEF publications on children's health and publications by the United Nations Population Fund (UNFPA). The International Red Cross and international NGOs that are involved in emergency assistance are equally important sources to consider. Multilateral and/or bilateral assistance agencies that finance specific reform-support programmes usually generate information that can help clarify current policies.

B. QUANTIFICATION OF DAMAGE

1. Definitions

a) Direct damages

Direct damages are those caused to the health system infrastructure, as well as to the stock of medical equipment and inputs. The following components are usually the most affected:

- Hospitals, health centers, clinics, dispensaries and rural and urban health-care stations belonging to the national health or social security system;
- Health sector offices;
- Laboratories and blood banks;
- Rural and urban private sector hospitals and clinics;
- Medical and auxiliary equipment and medical and surgical instruments;
- Non-medical equipment and supplies used in the health sector;
- Furniture and basic material; and
- Stocks of medications and vaccines.

98 The magnitude of the damage to the health infrastructure and medical inputs/equipment will depend not only on the type of construction, but also on its location and the type and origin of the disaster.

b) Indirect losses

Indirect losses occur after the event that caused the disaster; they refer to the consequences for the economic flows of the sector. Indirect effects thus include the reduction in the level of normally available services, the additional cost of caring for victims, including the cost of relocating services and personnel into emergency services, the cost of maintaining idle human resources as a result of the impact on infrastructure, the reinforcement of epidemiological surveillance, the increased cost of medical treatment, lost income, activities associated with emergency care, delivery of medications and other inputs, vector control, vaccination, psychological care and so on.

The nature of indirect losses varies greatly. The following are some of the main types:

- The costs of monitoring and controlling the spread of infectious and contagious diseases and the harmful effects on health;
- The public and private cost of hospital and outpatient care;
- The cost of reinforcing primary care in rural areas and for vulnerable groups;
- The decline in the victim's well-being and living standards due to the general erosion of the standards of public hygiene;

- The general decline in activity in the formal and informal productive sectors resulting from the psychological trauma suffered by the affected population (this is usually measured in the estimates for the corresponding productive sector);
- The additional cost of treatment and health care for the affected population; and
- The additional cost incurred to reduce the vulnerability of the sector's buildings

C. ASSESSMENT METHODOLOGY

1. Direct damages

Public and private health-sector authorities are the main sources of the information required for assessing direct damage. Information may also be requested from the decentralized government services that normally operate in the affected area.

Information on current prices in the construction sector can be obtained from authorized professional entities (engineers' or architects' associations, construction chambers).

Given that the disaster's consequences can also be analyzed as part of an operational review of the health-care services network and model of care –on the regional or country level, depending on the magnitude of damages– the health and social security ministry can provide indicators of activity that make it possible to judge the functionality of a given structure and decide whether it should be repaired or replaced. The disaster can thus provide an opportunity to lower the operating costs of structures that no longer ensure that the population will receive effective service.

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a) Damages to infrastructure

To assess direct damage to health sector infrastructure, the same general procedure described in the chapter on housing and human settlements should be followed. That discussion defines three broad types of damage to infrastructure:

i) **Structural damage:** beams, joists, structural flooring, load-bearing walls, foundations and so forth;

ii) **Non-structural damage:** partition walls, interior installations, doors, windows, non-structural roofing, floors and so on; and

iii) **Deformations to the land:** settling, shifting and so forth.

Starting with a list of health infrastructure in the area affected by the disaster, with the facilities organized by type of establishment, the specialist will proceed to diagnose the damage. As in the case of housing, it is advisable to classify the facilities into the following groups: buildings that were totally destroyed or that are beyond the possibility of repair; buildings that were partially destroyed or that can be repaired; and buildings that were not affected or that suffered minor damage.

In other words, after collecting reliable data on the number of damaged or destroyed hospitals, health-care centers and other infrastructure in the sector, the specialist should seek up-to-date information on the value per square meter of new construction or repair, as is relevant in each case.

Next, each facility must be specifically identified, with details on its location, category, the main materials used in its construction and the unit prices for its reconstruction, full replacement or repair, as required in each case. The cost estimate for repairs should be expressed as a percentage of the cost of full replacement, as estimated by the assessor responsible for determining whether the facility should be repaired or partially rebuilt (see Table 3).

To assess the effects on the service network, the specialist should also categorize the affected health sector facilities by i) geographical area, ii) level of care, iii) number of beds and iv) public versus private. The analysis should include a description of the post-disaster situation in each of these categories. As part of this analysis of the impact on the services network, the specialist should also assess the affected infrastructure as a percentage of the total (see Table 4).

b) Furniture and equipment

100 The assessment of the damage to furniture and equipment can be based on the same three categories used for infrastructure: i) no possibility of repair (necessary replacement); ii) possibility of repair; iii) and minor damage.

To estimate the cost of repairing or replacing medical equipment and furnishings, depending on the level of the facility, either a coefficient can be allocated to each hospital bed to represent the value of the equipment and furnishings associated with it or an estimate can be made on the basis of existing price lists or price lists prepared for this purpose.

In the case of specialized equipment, however, it will be necessary to determine the current cost of replacement and whether the item must be imported.

The assessment must also take into account possible damages to non-medical equipment. This encompasses all non-medical equipment necessary for maintaining the sector's operations, from the air and water quality control system to personnel administration. Examples include air conditioning units, heaters, refrigerators for storing vaccines, office equipment, air purifiers, water filters and the like.

A table can be drawn up to summarize the estimated damage to infrastructure and equipment, with a breakdown by degree of damage and a detail of the associated costs, as follows

Table 3

DIRECT DAMAGE TO INFRASTRUCTURE AND EQUIPMENT

	Replacement		Repair		Minor damage	
	Units	Ave. cost (per sq. m)	Units	Ave. cost (per sq. m)	Units	Ave. cost (per sq. m)
Hospitals						
Clinics						
Health-care stations						
Pharmacies						
Laboratories						
Medical equipment						
Non-medical equipment						
Furniture						
Other						
Total						

Table 4

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AFFECTED INFRASTRUCTURE AS A PERCENTAGE OF THE TOTAL

	Replacement		Repair		Minor damage	
	Units	% of the total	Units	% of the total	Units	% of the total
Hospitals						
Clinics						
Health-care stations						
Pharmacies						
Laboratories						
Total						

2. Indirect losses

a) Demolition and clean-up costs

The costs of demolition, removal of debris and land improvement are considered indirect losses. This assessment should be carried out in close cooperation with the government officials responsible for the sector. Demolition costs vary widely in relation to the type of building materials involved. The specialist should thus consult with an engineer or architect on this point. The costs of removing debris are usually estimated based on the volume to be removed and the unit cost of removal and transport to the waste disposal location.

b) Cost of disaster mitigation works

It is often necessary to adopt mitigation and prevention measures to avoid or reduce the impact of future disasters on the sector's infrastructure. The costs of such works or measures, as well as the costs of relocating facilities to less vulnerable sites, are considered an indirect effect of the disaster.

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The mitigation of disaster-induced losses via the adoption of preventative measures is a highly profitable endeavor in areas that experience recurrent events. Each dollar spent on adequate mitigation before a disaster hits represents enormous savings in losses that could have been avoided. Different mitigation measures have different implementation modes and costs. The simplest and most economical are those associated with non-structural and organizational-administrative aspects, whereas structural measures are more complex and expensive.

Phasing in an integrated hospital damage mitigation plan will facilitate a slower, more feasible application of resources. The practical experience gained in hospital damage mitigation works over the last ten years, together with current information on the building code, can serve as the basis for estimating these costs.

c) Cost of treating victims

From a medical standpoint, the classification of the wounded and injured according to the severity of their wounds and their chances of rehabilitation is especially relevant. When a disaster causes a relatively large number of victims, it is not possible to attend to all of them at once. In such cases, medical or paramedical personnel should sort the victims by triage at the time of search and rescue operations. Triage is essential for optimizing existing curative resources, since it describes and sorts the victims while making it possible to estimate the cost of treating and rehabilitating both the seriously and slightly injured.

Health specialists may face two alternative situations. Under the first scenario, primary victims are few and relatively concentrated, and the normal relief and treatment services in isolated or remote regions are capable of dealing with all the cases without too great a delay. In this case, information will generally be centralized, and the health specialist should therefore have no difficulty in estimating the additional costs related to additional medical examinations, hospitalization costs, long-term treatments, the increased demand for medications and sedatives, overtime work by medical and paramedical personnel, transportation expenses for victims or for long-time patients who are deemed healthy enough to return home and so forth. The second scenario occurs when the number of primary victims exceeds the capacity of primary and hospital health-care services both inside and outside the devastated area. In view of the difficulty of estimating the cost of medical attention, the following standard is customarily accepted: no conjectural estimates are made to account for the wounded who are not registered in the national system or in the private health-care system, and the total cost incurred by the hospital system is estimated on the basis of the care given to the primary victims. In other words, the increase is determined as the total cost incurred by the system for search and rescue and the treatment and subsequent care of the trauma victims from isolated or remote areas. The accuracy of the estimate will depend essentially on the validity and reliability of the classification procedure and access to information.

If the number of existing entries in the registry is reliable, the health specialist should not have much difficulty estimating the costs. Otherwise, they may be able to estimate them based on the increased costs of the following interventions: i) the enlargement of the reception and treatment areas; ii) the length of stay of patients in the reception, treatment and hospitalization areas; iii) the treatment and recovery of hospitalized patients; iv) the treatment and recovery of outpatients, if justified by the availability of personnel; v) medical, paramedical and auxiliary personnel; vi) the evacuation of new and pre-existing patients; vii) transportation costs; viii) the treatment of patients sent home prematurely; ix) mobile units; and x) health inspections carried out in homes.

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These cost components can be rearranged to suit the public or private hospital system unit responsible for receiving the primary victims of the disaster. If some facilities charge for medical services, the value of the benefits thus given are replaced by the procedure described above. Finally, monitoring and registration of the victims' records will probably be centralized by the health ministry or other governmental body.

d) Costs of public health and epidemiological interventions

This section analyzes public health interventions necessary for preventing or controlling the spread of harmful effects from the disaster on public health.

Health measures following a disaster are generally palliative in nature. Their primary objectives are to control water quality, prevent epidemic outbreaks and ensure that the disaster's impact does not trigger the spread of latent diseases. With regard to epidemic outbreaks, the health specialist must identify those that are caused exclusively by the disaster event before registering the costs.

The following kinds of interventions are rapid and are generally coordinated by the health ministry. It is important to request that the health ministry provide all the available information on these interventions (resources, operation, financing commitments, nature and amount of outside aid, etc.). The associated costs must be identified for each intervention, if it is implemented.

- Water. This category includes the cost of supplying the population with simple materials outlining instructions on i) the need to check water quality before using the water; ii) uses for sterilized water; iii) the danger of storing water in broken, dirty or uncovered containers; and iv) the importance of keeping wells, springs or other sources of raw or potable water free of contact with human and animal excrement, trash and industrial or domestic waste water.

Water quality must also be monitored (this is defined and estimated under the heading water and sanitation in the chapter on infrastructure). The process might include carrying out an analysis of water quality (residual chlorine or bacteriological quality), overseeing sterilization, monitoring the quality of water distributed via water tanks and so forth. Public health authorities will have the responsibility of ensuring that all shelters and affected population without access to water sources have appropriate, undamaged water storage containers, whose capacity is sufficient for the number of people in the shelter.

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If the shelters do not have water storage containers, some type of storage facility will have to be provided (PVC, fiberglass or asbestos-cement tanks). Water sterilization tablets may also be distributed to the affected population or shelters.

Another cost to take into account is the removal of the corpses and remains of buried or partially buried animals.

- Sanitation control. This item includes public health educational activities concerned with food handling and domestic hygiene, as well as health inspection of living quarters and temporary shelters for the victims or the primary affected population. Measures that might be carried out include mass public awareness campaigns, talks with affected groups, visits to shelters and so on. The wide-scale or selective distribution of protective products might also be undertaken, as in the case of masks for filtering ash in an effort to prevent respiratory problems following a volcanic eruption.

- Fight against vectors. This includes the cost of destroying and monitoring new foci of vector reproduction, as well as the fight against the vectors themselves. It includes the localized application of rodent controls and insecticides, the protection of domestic water supplies, the destruction of unnatural water collection areas, the detection and treatment of cases and prophylaxis, if necessary. This item should also include health education and the distribution of repellents or barriers to reduce contact between people and the vector.

- Vaccination campaigns. It may be necessary to carry out mass vaccinations (typhoid fever, cholera) or selective campaigns (for example, children and measles); such costs should be considered an indirect effect of the disaster. At the same time, efforts should be made to avoid interrupting the regular national vaccination programmes, which may require the following actions: i) immediately reinstate the vaccinations routinely given in national immunization programmes; ii) propose the temporary use of cold boxes (RCW42) to ensure the preservation of vaccines in affected areas and consider the possibility of mobilizing immunobiologics, provided ice is available; iii) resort to the use of photovoltaic refrigerators for storing vaccines and producing ice, given the availability of sufficient batteries; and iv) initiate the recovery of the cold chain (purchase of refrigerators, thermoses, thermometers and so on).

- Epidemiological surveillance Epidemiological surveillance after a disaster involves four fundamental steps: i) investigate rumors and reports of cases in the field; ii) approach laboratories to obtain definitive diagnoses and support for epidemiological investigations; iii) present epidemiological information to decision makers; and iv) ensure surveillance during and after the rehabilitation phase. It is necessary to determine the cost of the following items: epidemiological surveillance in health-care facilities and in the community (including field research, data processing and laboratory analysis); the quarantine, isolation and treatment of the first cases; and finally, the epidemiological surveillance of people housed in shelters.

- Food safety. The health sector may contribute to the formulation of intersectoral post-disaster policies on food safety by providing information and orientation as needed. The health sector is also responsible for preserving the sanitary condition of food donated by humanitarian aid. It must also monitor the nutritional status of the affected population (for example, via surveys), given that the decreased availability of food could lead to malnutrition from a lack of protein or micronutrients, such as vitamin A, vitamin C or iron. All of these actions should be included in the cost assessment.

The main source of information will be the national emergency committee and the health ministry. In principle, all relevant epidemiological information should be included.

The health specialist will probably find that the relevant information has already been classified in some form. In any case, it is useful to verify the validity and reliability of the available information or to make one's own cost estimates.

Health specialists should give particular attention to the following items:

Cost of personnel. This item should include the cost of the additional personnel and regular staff overtime needed to tackle the post-disaster situation. Special attention should be given to the additional personnel recruited by the health system and assigned to disaster-related public health interventions, water quality control, epidemiological surveillance, vaccination campaigns, laboratories, environmental health and the fight against vectors. The cost of special brigades for health-related actions or epidemiological surveillance must also be accounted for. Other costs include the training or orientation of personnel for the implementation of disaster-related public health measures.

Cost of material and equipment. Here, the costs to be considered include the purchase, storage and distribution of equipment, medications, vaccines and pharmaceuticals used for preventative purposes (and curative, in the case of transmissible diseases) to counter the effects of the disaster. The logistical costs of vaccination campaigns are also included, as are the costs of equipment that had to be purchased for vector control and for sanitary control measures that form part of the disaster response. The cost of imported medications should be accounted for separately.

Cost of diffusing public information. The cost of diffusing public health information must be measured, whether it involves mass social awareness campaigns, educational programmes targeting the affected population or talks with vulnerable groups.

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To avoid double accounting, it is important to distinguish between the cost of personnel, material and equipment involved in the treatment of victims and those channeled into the aforementioned public health measures. The former should be taken into account under the first heading of indirect effects (the cost of treating the victims), whereas the latter should be analyzed and incorporated here.

The health specialist's first task is the identification of the costs associated with sanitation and epidemiological surveillance operations. The second, and more difficult, task is to determine which disaster-related effects can be considered aftereffects. This distinction should be taken into account especially for epidemiological surveillance activities such as the collection and interpretation of data to determine the risk (or presence) of outbreaks or foci of transmissible diseases. It is generally said that a disaster does not "produce" transmissible diseases, but merely modifies environmental conditions, thereby unleashing latent diseases. When changes in the incidence of disease are detected, the only way of knowing with any degree of certainty whether an increase can be ascribed to the disaster is to refer to the epidemiological records and the health organizations' reports.

Additional sources include sectoral programmes run by international organizations, which often maintain their own information systems. Health specialists can also draw on the following sources of information:

- Project presentation documents;
- Press reports; and
- Interviews with health personnel.

e) Increased cost of preferential health care for vulnerable groups

While there are many, complex causes of vulnerability, experience shows that the chief cause is poverty, especially in the case of single mothers, children under the age of five and the aged. Likewise, after a disaster, pregnant women and the undernourished are the population groups that are most exposed to risk, especially infectious and contagious diseases. Other highly susceptible groups include adolescents, unaccompanied minors and people with disabilities. Consequently, the protection of these groups after a disaster requires specific health interventions. Special health operations are also often carried out for other groups that have been particularly affected by the disaster, such as rural families and farmers whose land has been severely damaged by flood or prolonged drought. The cost increase resulting from these special interventions on behalf of vulnerable groups should be estimated and recorded as an indirect cost.

f) Additional indirect health service operating costs

The destruction or crippling of the public and private hospital, primary care and other health infrastructure, together with disaster-related deaths and injuries to medical and paramedical personnel, force the national and private health system to incur additional operating expenses. These are described below.

Failure to meet income forecasts. If there is a lack of qualified personnel or if the infrastructure is put out of service, this might lead to a reduction in income from the charged services of the national public health system and of private clinics and hospitals. The health specialist should determine the value of such a reduction in future expected income for outpatient and hospital services by referring to the applicable rates prior to the disaster.

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The calculations can be simplified by using earnings and cost indexes that have been previously established by the hospitals' planning departments. A more precise assessment can be made when there is a hospital information system that keeps records on the volume and relative cost of the assumed illnesses.

Non-provided health-care services. It is also necessary to estimate the cost of the services, whether free or subsidized, not provided by the public health system. Two types of calculations can be used to make a quick assessment. The number of non-performed outpatient examinations, surgical procedures and hospital treatments can be estimated and evaluated on the basis of established prices. When this information is unavailable (or when there has been considerable destruction or impairment of the infrastructure), it is preferable to use the "foregone income" of the medical, paramedical and auxiliary personnel while activities are stopped. The average individual salary of each of these categories should be multiplied by the total number of shifts not worked and by the number of members absent in each of the health officials' categories.

The valuation of this item should consider the possible reduction in costs owing to the total or partial non-operation of certain health-care facilities, with a corresponding decrease in the purchase of inputs and payment of basic services used in the operation of these facilities.

Increased costs of providing services. This item covers all additional costs incurred by the public and private health-care services to ensure that services are available, except i) those services provided to direct victims of the disaster and ii) the public health-care services mentioned above. In general, it encompasses the increase in the cost of services stemming from the disaster, the expense of replacement personnel (estimated in the same way as in the preceding paragraph), the relocation of outpatient services, the strengthening of the infrastructure, transport, public information costs, importation of medications and instruments and so on. It is essential to take into account that the use of resources to prevent the consequences of a disaster has a cost inasmuch as these resources are no longer used for their originally intended purposes. The health specialist thus has the choice of estimating these resources from the point of view of the benefits that they will have ceased to supply because they are being used for disaster-related needs and estimating them in accordance with the replacement value of the service supplied.

When calculating increases in health-care operating expenses, health specialists must include all expected future services, even though they might not yet have been supplied, because they represent a net loss for the beneficiary population.

108 Interruption of aid programmes. In many countries, the national health-care services are in charge of implementing and distributing some social aid programmes (distribution of milk, family assistance programmes, advance payments of health-care expenses, etc.). Such programmes are often interrupted when a disaster occurs. Since a good number of these programmes are only briefly interrupted, often without important consequences for the beneficiaries, the health specialist should use his/her judgment in estimating the corresponding costs. If beneficiaries suffer net losses during the time that such programmes are suspended, the cost of these losses must be calculated for the time that the services are expected to be suspended. The same goes for the additional costs that will probably have to be incurred to speed up the normal supply of these benefits.

g) Increased public and private costs owing to higher sickness rates

The increase in morbidity owing to causes attributable to the disaster, as confirmed by the people in charge of epidemiological surveillance services and by the health specialist, entails increased costs for both the national and private systems, as well as for the victims themselves. Health specialists who make a quick assessment of the damage may find that information is scarce. In these circumstances, the easiest thing to do is to record the additional public and private costs that will have to be incurred, using an estimate of the number of cases to arrive at the costs. When there are many cases spread over a wide area, the first task will be to verify the two categories of cost attributable to the disaster:

- The treatment of primary cases (quarantine, isolation, etc.); and
- The increased costs to the sector for the provision of additional services.

If either or both of these items incur costs, the health specialist should separate the additional costs that are attributable to the higher level of sickness from the additional costs that are attributable to other causes. This will ensure that the same costs are not counted twice and that only the increase stemming from the greater morbidity rate is measured.

Disaster-related morbidity forces individuals to incur expenses, lowers production and gives rise to medical or hospitalization costs. The health specialist should work in cooperation with the macroeconomic specialist to assess these related losses and add them to the costs incurred by organizations. There are two ways of calculating these sickness-related production losses. In the first, the average per capita production figure is calculated for a defined period using a process of prorating and extrapolation, and this is then subtracted from GDP. This method facilitates comparison, but it fails to show that the activities do not fall within a single segment of society and that sickness is not distributed evenly throughout the population. The second method is based as much as possible on the productive activity of the sick. It consists of defining the groups of different income levels that may be affected and then arriving at the amount of lost production by calculating the number of days not worked. Nevertheless, these costs do not include the “intangible effects” on the quality of life of the sick and their surroundings.

The difficulty here is to express the cost of the effects on morale and psychological suffering in monetary terms. In order to estimate the additional costs related to the increased morbidity, an average cost per sick person should be estimated. In the case of medical expenses and the cost of medications, this may be done either by referring to existing tables or by using all of the sickness-related costs of a sample of the sick. These figures (that is, lost production, medical expenses and medications) should be applied to the part of the population recognized as being sick from causes attributable to the disaster. If treatment costs differ appreciably according to the patients’ age, this will have to be taken into account by separating particular age groups.

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D. MACROECONOMIC EFFECTS

The health and macroeconomic specialists should work together to determine the macroeconomic effects originating in the health sector.

a) Diminished contribution to development growth rates

Losses should first be measured in terms of the health sector’s contribution to gross domestic product (GDP). Health is a service sector that creates multiple jobs and has many ramifications, including knowledge investment (scientific research), human capital investment (training and education) and material investments (buildings and materials).

National accounts can be used to measure the reduction in the sector’s output as a percentage of GDP. In the case of the private sector, this reduction may be assessed using the criteria of businesses in the industrial and commercial sector. For the public sector, one should first calculate average production and then apply the figure to the estimated period of suspended or reduced activity.

b) Effects on employment

The damage caused to infrastructure may lead to unemployment among sector personnel. In most cases, these employees will continue to receive their wages. The actual number of jobs lost in the relevant period will, however, have to be estimated.

c) Effects on the external sector

A disaster's effects can have an impact on imports and exports insofar as the raw materials and equipment needed for reconstruction are concerned.

- In some countries, the construction or repair of health infrastructure entails importing materials and equipment that are not produced locally. In this case, it is important for health specialists to work closely with the officials responsible for the sector on a national level to determine the quantities and costs of the products and materials to be bought overseas, and then to estimate the portion of imports that are destined for the reconstruction effort.

- If damaged or destroyed buildings and equipment are insured with a local insurance company that has reinsured that risk with a foreign company, an influx of foreign currency may result. The health specialist should obtain information about this by questioning the insurance companies.

d) Effects on public finances

The health specialist must determine the increase in public budgetary outlays needed to meet emergency, rehabilitation and reconstruction requirements. This estimate can be made by adding the amounts spent during the emergency stage to projections on rehabilitation and reconstruction projects.

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In addition, the government may experience a drop in normal income, since any reduction in the services provided by private health-care establishments translates into a corresponding decrease in the amount of taxes paid. When estimating such losses, the normal tax rate for these cases should be taken into consideration.

e) Effects on prices and inflation

The magnitude of the damages might be so great that the reconstruction needs for all sectors –not just health– leads to a scarcity of construction materials and equipment and causes prices to rise. The health specialist should search all available sources to obtain information about prevailing prices before and immediately after the disaster so as to make allowances for any increase and to project price movements. To do this, the health specialist must collaborate closely with the specialist in housing and human settlements.

f) The differential impact on women

As in other sectors, the disaster affects women differently than men. In the health sector –as in education and culture– women account for a higher percentage of workers than men, such that any loss in employment and income will affect them directly as a group. Furthermore, whenever overtime is required of health sector workers, women's overall work load will be increased beyond the compensation of the additional income they may receive, as they must still discharge their reproductive activities after returning home late.

To determine these differential effects on women, the health specialists must work in close cooperation with both the employment and gender specialists of the assessment team to ensure that these losses are properly estimated and that no double accounting occurs.

As in previous chapters, an example of the application of the methodology described above is provided in the following appendix, using information obtained during a recent disaster.

APPENDIX VI

ESTIMATE OF DAMAGES IN THE HEALTH SECTOR CAUSED BY THE 1999 MUDSLIDES IN VENEZUELA¹

Torrential rains occurred in December 1999 along Venezuela's northern coastline after a low-pressure trough stalled over the Caribbean for nearly 20 days. The resulting mudslides and flooding had catastrophic effects on the population, urban infrastructure, basic services and productive infrastructure, as well as incalculable effects on the environment. The states of Vargas, Miranda and Falcón were the most severely affected.

1. Health sector

The health sector was unable to respond fully to the extraordinary demand arising out of the catastrophe as a result of damage to physical infrastructure, access to facilities and the availability of personnel –areas that were already showing weaknesses and inequalities before the events of December.

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The physical plant of hospitals and outpatient centers sustained varying degrees of damage in the hardest-hit regions –especially in the state of Vargas– with some rendered non-operational as the tragedy unfolded. Even the medical facilities that could continue working were completely cut off, as many roads were washed out. The loss of furniture, equipment, materials and medications –exacerbated in some cases by looting– was another difficulty that had to be faced, as was the effective loss of personnel, a third of whom were themselves victims (in Vargas) while others were unable to reach work owing to difficult conditions on key roads, including the Caracas-La Guaira highway.²

Medical reinforcements were deployed from abroad during the initial relief effort, including more than 400 Cuban doctors, paramedics and nurses who worked in the most devastated areas. International shipments of equipment and medications also helped alleviate much of the immediate shortage.

Once the emergency phase –rescue, emergency medical care, finding the dead³ and moving victims to temporary shelters– had passed, environmental and epidemiological surveillance efforts were stepped up so as to minimize risk factors. In an effort to involve the public at large in Vargas, health brigades were formed and given training in the handling of toxic solid waste, food preparation and conservation, water treatment and vector control.

¹ ECLAC, *Los efectos socioeconómicos de las inundaciones y deslizamientos en Venezuela en 1999*, Mexico City, February 2000.

² Many health-care workers missed paydays because service had been suspended at the banks where their wages are normally deposited.

³ The Attorney General's Office was entrusted with locating the corpses of victims.

Other emergency-phase priorities included repairing damaged health-care facilities. At the beginning of 2000, Venezuela had 182 hospitals, as well as 707 urban and 3 541 rural outpatient clinics.⁴ Most of the damage was concentrated in the states of Vargas, Miranda, Falcón, Yaracuy and the Federal District, in which a total of 31 hospitals and 687 outpatient clinics are located. Of these, 9 hospitals (29%) and 251 outpatient clinics suffered damages, ranging from minor to total loss. The extent of the damage may not seem significant as a national percentage, but it is clearly quite high in the disaster areas, affecting health-care services for 360 000 disaster victims (see Table 1).

Table 1

VENEZUELA: HEALTH-CARE FACILITIES DAMAGED IN THE MOST SEVERE DISASTERS AREAS

Federal Entity	Hospitals			Out-Patient Clinics		
	Total	Damaged	%	Total	Damaged	%
Total	31	9	29.0	687	251	36.5
Vargas	5	5	100.0	36	26	72.2
Federal District	6	1	16.7	76	-	-
Miranda	12	1	8.3	178	107	60.1
Falcon	3	1	33.3	308	97	31.5
Yaracuy	5	1	20.0	89	21	23.6

Source: Ministry of Health and Social Development and PAHO/WHO

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Most of the health-care facilities in Vargas were affected, to varying degrees. Five outpatient clinics and two hospitals were severely damaged.⁵ The Macuto maternity hospital (Hospital Materno Infantil de Macuto) was completely covered by mud, destroying its 120 beds and other equipment, but apparently leaving the building itself in tact.

The state psychiatric hospital was similarly affected. The Venezuelan Social Security Institute's Hospital Vargas, which was not open to the public at the time of the disaster, was quickly cleaned up and pressed into service to cover spillover from other besieged medical facilities. The Pariata and La Sabana hospitals functioned at 70% of their normal capacity, while the Naiguatá hospital operated at 40%. Outpatient clinics proved to be the most vulnerable. The type III clinic, "Dr. Alfredo Machado" at Catia la Mar, a key medical facility in a heavily populated parish, was completely covered by mud, and it struggled to provide some services at a church next door. In Vargas alone, six outpatient clinics were deemed a total loss.

⁴ See Censo de Establecimientos de Salud de las Direcciones Generales Regionales de Salud, 1998.

⁵ The state of Vargas had three specialized hospitals (Hospital de Niños Excepcionales, Hospital Dermatológico "Martín Vegas" and the Hospital Materno Infantil de Macuto), two type III hospitals, 19 urban outpatient clinics (5 type III, 1 type II and 13 type I) and 17 rural outpatient clinics (all type I).

The Federal District's oncology hospital suffered extensive damage to its very costly equipment, but with some well-known exceptions, most facilities were easily restored following clean-up and the restoration of the water and drainage systems and roads.

Direct damage to physical plant at health-care facilities was estimated at 18 million dollars, plus 11 million dollars in lost equipment and furniture. Total direct cost to the sector thus reached 29 million dollars. The cost of fully rebuilding damaged facilities, incorporating modern materials and equipment, was estimated at around 55 million dollars.

Table 2

VENEZUELA: DAMAGE TO THE HEALTH SECTOR a/
(Millions of dollars)

Item	Total	Direct	Indirect a/	Reconstruction Costs	Foreign component
Total	61.0	29.0	32.0	55.5	4.2
Total or partial destruction of healthcare infrastructure	18.0	18.0		32.4	2.3
Loss of equipment and furniture	11.0	11.0		23.1	2.0
Increased allotments for hospital and out-patient care b/	12.0		12.0		
Additional costs for sanitation, vaccinations and epidemiological control b/	8.0		8.0		
Retrieval and treatment of trauma victims	1.0		1.0		
Medical, psychological and food assistance at b/	8.0		8.0		
Cost attributed to the diminished capacity of healthcare services	3.0		3.0		

Source: ECLAC, based on data supplied by the Ministry of health and Social Development and PAHO

a/ Includes estimated costs affecting the public health system, as well as both for-profit and non-profit private health-care facilities.

b/ Includes cash and material aid from other nations.

Of even greater significance for the sector were the extraordinary outlays it made –with assistance from the international community, civil society and the local community itself– which were estimated at 32 million dollars. These emergency funds went primarily to special care for injured and displaced persons and to preventative health and vaccination campaigns. Total direct and indirect costs attributable to the health sector thus reached 61 million dollars.

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ECLAC

Section Three

Infrastructure

Introductory note: Three main infrastructure sectors are included in this section: energy (both the electric power and oil segment), drinking water and sanitation, and transport and communications.

I. ENERGY

A. INTRODUCTION



Energy, like all other sectors, sustains direct damages and indirect losses during and after disasters, and their macroeconomic impact must also be ascertained. Direct damages refer to the immediate damage or destruction of physical infrastructure and inventories available at the time of the disaster. Indirect losses refer to the costs of satisfying demand for energy during the recovery period, as well as the net income or profit that is not received in said period. These indirect losses are used to separately assess the macroeconomic effects.

One must determine the repair or reconstruction costs required to reestablish pre-disaster operating capacity. A decision must be taken as to whether the new operating capacity should be equal to the one in place prior to the disaster or incorporate updated efficiency and security standards. Valuation criteria at current replacement cost—including technological innovations—will provide a more accurate cost of the works to be carried out in practice and the financial resources they will require.

The cost estimate must take into consideration the time needed for repair work to be completed and the costs of meeting temporary needs, as explained below in the section on indirect losses.

It is much easier to estimate stocks of equipment, materials and raw materials that were damaged or destroyed by the disaster, with replacement costs at current market prices. If at the time of the assessment, there are no equal goods available in the market, it is necessary to use the cost of the most similar goods in order to obtain equivalent or approximate results.

The quantification of indirect losses is a more complex task because it is based to a greater degree on estimates. On the one hand, the behavior of supply and demand during the rehabilitation period must be estimated; on the other, the financial results that will actually be obtained over the same period must be compared to those that would have been obtained if the disaster had not occurred. In the projection of what will happen after the disaster, results will clearly be lower than those estimated before the disaster, because large consumers will have reduced their energy demands. Though it is less likely, energy demand could increase if large amounts of energy are required for repair works. Both situations may actually occur concurrently, in which case a quantification of the net results must be made.

Once the analyst has determined post-disaster demand –which can be equal to, smaller than or greater than normal demand– the means to properly meet it must be identified. As a general criterion, assume that demand for energy will be met somehow. Then estimate the required capital and operating costs, based on how long it takes to rehabilitate all facilities. Capital costs essentially refer to the purchase of equipment, while operating costs consist of labor and materials. Personnel costs should include salaries of plant personnel temporarily laid off for any reasons arising out of the disaster.

Finally, indirect losses must be estimated. Begin by estimating the net income that can be obtained during the rehabilitation period. Then subtract the cost of temporary energy supplies in addition to the company's operational costs during the rehabilitation period from estimated income from energy sales in the same period. Keep in mind that net income thus estimated might be negative depending on the post-disaster purchasing capacity of consumers. Second, estimate the net income that would have been obtained had the disaster not occurred by subtracting total cost from gross income, just as was done in the previous example. This information is often available in the records of companies that manage the sector, especially in their respective short- and medium-term planning departments. The amount of total indirect losses can be determined by the algebraic difference –applicable in cases of real negative income– between the two previously estimated net incomes. These indirect losses would already include the additional costs of temporarily meeting demand, as well as the income that will not be received because of the disaster.

2

The previous estimates of costs stemming from direct and indirect damage should be broken down, on the one hand, into local and foreign currency components so that they may be used for the overall balance-of-payments calculations. On the other hand, distinctions must be made with regard to damage and losses corresponding to the public sector and to private enterprises, with a view to their utilization in subsequent estimates of national accounts for the calculation of macroeconomic effects.

We recommend the following assessment methodology for the electricity and oil sectors.

B. ELECTRICAL SECTOR

1. Direct damage

Direct damages in the electrical sector usually affect the following three major components of the system: electricity generation plants; transmission lines and distribution grids; and power distribution centers.

a) Electricity generation plants

Electrical energy is generated by hydroelectric and geothermal power plants, as well as by conventional thermal power plants driven by steam, diesel and gas turbines. For the purposes of this Handbook and in light of their special characteristics, consideration is given first to civil works required for the generation of the hydroelectric and geothermal energy. Second, we deal with the power generation plants, where the equipment to transform raw energy into electricity is located.

In connection with hydropower generation, water resource development may require a wide range of works such as diversion and storage dams, channels, tunnels, oscillation chambers and pressurized pipelines. Damage to these facilities must be repaired in order to restore the water supply required for electricity generation; failure to do so would result in the power plant becoming non-operational, and the entire electrical system would be affected. The aforementioned facilities are often located some distance from the main communication routes, so access can be difficult, at least during certain times of the year. In these cases, the direct effects should include any additional costs to repair communication routes; this should not be included in the damage quantified for the transportation sector to avoid double accounting.

To assess the cost of rehabilitation and/or reconstruction of the affected facilities, first an estimate must be made of the following units involved: cubic meters of earth to be removed, including specifications of the type of material involved; amounts of concrete that may be required, broken down by type and strength; the length and other characteristics of water conveyance lines; and the main mechanical components and special facilities. Then an estimate of costs should be made based on current unit values for each type of component. Alternatively, depending on the basic information available, a more detailed procedure can be followed that would consider labor needs by specialty, the amounts of raw materials, the time of use of construction equipment and the unit costs for each of these components. In both cases, the type of damage sustained by the facility, access to basic construction materials -earth, sand and gravel- and the availability of both unskilled and specialized labor will have a direct bearing on the estimation of direct costs. In this regard, cost estimates and bidding proposals made by contractors that have had recent experience in the affected area or in regions with similar conditions will be a valuable source of information.

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When considering geothermal power generation, resource extraction and management includes deep wells, conveyance pipe systems and specialized equipment for the processing and collecting of steam. Any estimate of damage to the availability of geothermal power falls outside the scope of the present Handbook and will require the assistance of experts and field research. However, the electrical sector specialist might try to make order-of-magnitude estimates based on updated average costs of drilling deep wells in the area under consideration or in other areas having similar geological characteristics. The alternative procedures that have already been described for hydropower plants should be followed to estimate costs for any remaining generation facilities.

The remaining components for electricity generation refer to the power plants themselves, including the building and a wide array of mechanical, electrical and electronic equipment. An analyst should first focus on equipment and machinery that deliver power to the generator; this basically covers equipment to collect hydraulic energy in hydroelectric power plants and equipment that uses heat energy through boilers, pressure tanks and steam and gas turbines. The former are individually designed to match the characteristics of the hydroelectric site, and their replacement must follow a similar procedure. However, their costs can be estimated by updating the original investment using indexes that reflect the trend in international prices of similar equipment. Manufacturers' catalogues and statistics that show the costs of equipment to collect hydraulic energy in hydroelectric power plants by range of water height (meters) and flow (m^3/sec) of the water resource may also be used.

Equipment used for the mechanical processing of energy obtained from steam and from burning oil derivatives is more standardized, although it has specific characteristics depending on the size and type of facility. This includes geothermal as well as conventional power plants classified –depending on the fuel used– as steam-, diesel-, and gas- driven plants.

Their replacement costs can be estimated following the general procedures mentioned above for hydroelectric power plants, which normally are easier to estimate because the equipment is more standardized. Power plants use a range of largely electromechanical equipment to convert raw energy forms –hydraulic, geothermal and those derived from oil derivatives– into electricity. This equipment is generally similar for different types of power plants, but it may vary depending on how up-to-date the plants are and on their specialized functions. The determination of replacement costs first takes into account investments for the original purchase –especially if this was done recently– updated to account for international inflation. A second alternative is to consult cost catalogues published by the manufacturers of this equipment or costs statistics available in specialized publications.

The above comments refer to cases in which installations must be totally replaced. When damage is less severe and only repairs or rehabilitation are required, the cost estimate must be preceded by a technical assessment of the scale of the damage and the real chance of repair. This work will require the participation of specialized personnel having wide experience in the repair and maintenance of this type of equipment. Laboratory tests of the affected equipment will be required to obtain more exact estimates, something that cannot be done in the relatively short time usually available to the disaster assessment team.

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The buildings that house all generating equipment must also be assessed. The assessment of their direct damage will follow the same procedures as described for other buildings, as explained below.

b) Transmission and distribution systems

This heading includes transmission, subtransmission and distribution lines and grids, as well as all electrical substations that may be directly related to transporting the electrical power from the generation plants to final consumers.

High-voltage lines that use large and expensive pylons should be assessed first. To do this, field surveys will be required, making use of fast means of transportation such as automobiles when the lines are near to passable routes and light aircraft or helicopters in the case of cross-country lines. It is necessary to estimate the number of damaged pylons, the different types of pylon, and the length of affected electrical cables. In the case of lines that use uniformly distributed posts, only the number of kilometers of affected lines will be needed, with an indication of whether the damage is limited to the pylons or whether it also includes considerable lengths of cables. In addition, transformers and other equipment located along affected distribution lines must also be determined.

Thereafter, a list should be made of affected electrical substations, using the most precise indications possible of all equipment that has sustained any damage, including open-air facilities and equipment located in the main substations.

Estimates of the corresponding costs should be made on the basis of the results obtained from the inspection of the facilities described above. These should take into account all information available on affected power companies or those in neighboring areas. Because these data are frequently used, they should be readily obtainable. As in the case for electrical generation facilities, overall or broken-down costs could also be used, such as data from local or international contractors with experience applicable to the affected area, lists of equipment costs and catalogues.

The above comments on estimating damage in partially affected installations, in contrast to those that must be totally replaced, are also applicable to power transmission and distribution facilities.

c) Energy distribution centers and other works

Electricity measurement and dispatch centers and buildings for administrative offices are also of relevance in the electrical sector. The former are buildings that house a whole range of equipment to monitor and control electricity flows between power generation plants and the main consumption areas. These facilities may range from the most elemental, using manual controls, to the most sophisticated, employing modern remote-measuring and electronic computing systems with a high degree of automated and optimized basic functions. When total reconstruction of these facilities is required, cost estimates should be based on the comprehensive estimates of the energy distribution enterprise. An inventory of the respective parts and an estimate of the extent and magnitude of the damage are necessary in the case of partially damaged equipment and structures; experts should be engaged when specialized equipment is involved.

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Damage to administrative buildings and other facilities that might be affected by a disaster can be assessed relatively easily because the characteristics of such structures and constructions are well known. Average prices by unit of floor area or total horizontal space should be ascertained. For a more accurate estimate, unit prices should be estimated for the main elements that comprise such buildings, such as panels, walls, ceilings, window frames and so on.

2. Indirect losses

As previously noted, indirect losses include the additional cost of meeting interim energy demands during the rehabilitation period when affected installations are under repair; they also include net income or profits not received by the power companies during the same period.

a) Temporary supply of electricity

The calculation of the additional cost involved in the temporary supply of electricity will first require an estimate of the time required to rehabilitate the damaged infrastructure. The length of this period will essentially depend on the extent and magnitude of the disaster, and it must be determined on the basis of the assessment of direct damages. Next, it is necessary to estimate electrical demand during the rehabilitation period.

This involves determining the effect that the disaster had on the power company's main customers (generally consisting of industry, commerce and the residential sector). Residential demand projections should contemplate the number of unaffected dwellings; projections of industrial demand should reflect the number of facilities that are in a position to continue operating (including estimated demand for their products); and commercial demand estimates should take into account the operating capacity of the establishments in the affected area. Assumptions must be made for all sectors as to the purchasing power of customers in the period after the disaster to anticipate that potential source of demand constraints. These factors should make it possible to calculate the magnitude and characteristics of the total demand for power.

The electricity sector specialist should then examine alternative ways of supplying the estimated temporary demand. As was said above, this will generally be lower than if the disaster had not occurred, although some customers may tend to increase their use. This review should also contemplate possible solutions for ensuring a rapid re-establishment of electrical service.

In the case of systems in remote locations, all-in-one equipment solutions that can be mobilized and installed quickly in the main load centers should be considered. Their cost can be obtained relatively easily from specialized catalogues or based on recent purchases of such equipment for special needs, such as backup generators for industrial centers or for isolated populations not connected to the national power grid.

- 6 Operating costs can be estimated on the basis of specific fuel consumption requirements and the cost of delivery to the area that may be chosen for the temporary generators, which should preferably be located as close as possible to the centers of demand. Estimates of operational costs should be completed by adding labor and materials expenditures, which are normally obtainable from the cost accounting maintained by power companies for the operation of equal or similar equipment.

In the case of damaged systems that are not connected to the national power grid and that are located close to neighboring undamaged systems, the cost of temporarily providing electricity can be estimated quite easily. First, a determination must be made as to whether the undamaged neighboring systems have the capacity to provide the additional power and energy requirements. The cost of interconnection must then be calculated, including the cost of items such as lengths of transmission line, substation equipment and so forth. The rates at which the required power could be provided should be estimated next. If there are no existing agreements established for such emergencies, a reasonable rate based on the additional operating costs to be faced by the system chosen to temporarily provide the power supply should be estimated. In other cases, neighboring systems might be capable of supplying only part of the demand. In this case, the procedures indicated above for isolated and stand-alone systems should be used, in proportion to each one's contribution. Note that because the intention is to establish the additional costs of the provisional service, any reduction in operating costs compared to those the company incurs under normal conditions (such as the variable expenses of generating units that cease to operate because of the disaster) must be deducted from the aforementioned estimates for all alternatives considered.

b) Other indirect losses

Profits not received by the electrical utility during the rehabilitation period (after which demand would tend to normalize) are also indirect losses. It may be assumed that during this period the post-disaster reduction in income will limit the payment abilities of many consumers who need energy to speed up the recovery of their activities; such considerations can be reflected in a provisionally lower rate. It is possible to use such a provisional rate to estimate the gross income and real demand discussed in the previous section. Total costs during the interim period, including additional charges implied by interim service and the company's costs under normal conditions, should be deducted from the gross income thus calculated. This will yield an estimate of the net income during the period in question, which could be negative if there is an increase in expenses along with a reduction in income.

Net income should then be estimated as though the disaster had not occurred. On the one hand, expected income should be considered by applying estimated average income to the normal projection of electricity demand. On the other hand, an estimate of anticipated costs based on recent historic behavior, including direct and indirect costs, should be made in order to calculate normal income for the utility. Power utilities usually employ the expected surplus to cover capital investments made to adequately and opportunely meet future demand. Any significant reduction in operational surpluses would entail new loans that will only be granted if the respective company is financially profitable. Estimates for this second scenario are normally available in power utilities, which constantly require updated short- and medium-term planning.

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Indirect losses –which in this case would be equal to the profits not made due to the disaster– would be estimated as the algebraic difference between net income calculated for a normal scenario, with no disaster, and net income estimated for the disaster scenario, including any additional costs of supplying power during the rehabilitation period. Note that when net income is negative in the latter scenario, it must be added to the estimated net income for the normal scenario to obtain the total decrease in profits due to the disaster.

3. Imported content and breakdown of costs

The effects of the disaster on the balance of payments and national accounts may be ascertained from separating direct damages and indirect losses into foreign and national - currency spending requirements, on the one hand, and into public and private - sector spending, on the other. As far as direct damages are concerned, foreign-currency spending should include all equipment, materials and specialized labor that must be imported for the rehabilitation of facilities and machinery.

Local spending refers mainly to construction and repair costs, such as surveying work, earth removal, construction of structures and so forth. However, these items may also include significant foreign-currency spending on specialized equipment such as tractors, trucks and cranes that must be imported. The cost accounting records of power companies or those of contractors with recent experience in the region should prove useful for these estimations.

As far as the foreign-currency component of indirect costs is concerned, one should estimate the expense of temporarily meeting electricity demands in function of the equipment and materials that must be imported for such purposes. The costs of importing electricity from other countries should be included, when applicable.

The separation or breakdown of costs into public and private sectors depends on whether the affected power utility is state or private owned. In addition, when the government provides power services, participation by private companies in related activities, normally in reconstruction or repair contracts for the affected installations, must be taken into consideration.

C. OIL SECTOR

1. Direct damages

a) Production facilities

Oil production involves the drilling of deep wells on land or at sea and the extraction of crude oil. Oil transportation and storage, either for domestic refinement or for export to external markets, fall within the transport sector and should be estimated therewith.

- 8 Structures, equipment and facilities that are tailor-made to the needs and characteristics of the geographic environment are used to drill and operate the production wells. They include control rigs, deep drilling rigs, offshore platforms and a wide array of pipelines and equipment to handle the resulting flows of oil. When access to the underground oil deposits has been hampered by a disaster, estimation of damages requires that highly specialized personnel carry out field research.

Such activities are beyond the scope of this Handbook, which refers to estimates that can be carried out in a very short period of time. In the case of total destruction of a given well, the amount of investments already made, updated as of the date of the disaster, would provide a first estimate of direct damage. An approximation of indirect losses would be provided by the net commercial value of production lost during the rehabilitation period. This could then be refined through estimates of damage to such installations as rigs, drilling machinery and auxiliary equipment.

When such facilities have to be replaced because of total destruction, estimates can be made using (updated) standard costs that are normally available in the oil companies' files. Information on costs can also be obtained from manufacturers' catalogues in the case of industrial equipment. Contractors with relevant experience can also be approached. If damaged facilities and equipment can be repaired, it is necessary to assess the magnitude and extent of damage; such estimates require specialized experts with broad experience in repair and maintenance works, preferably familiar with the affected installations.

b) Oil refineries

Refining facilities may be simple when they only cover the stages of primary distillation, but they may be rather complex when they handle more processed products or remove harmful substances such as sulphur. Refineries generally include different kinds of processing towers, storage tanks and a wide array of pipes of differing diameters with various categories of valves and other fittings for managing fluids. Assessing disaster damage at oil refineries should follow the same or similar procedures as those described in the previous chapter for thermal power plants, as they often employ somewhat similar installations.

c) Distribution facilities

The distribution and sale of oil derivatives can be broken down according to the main user sectors as follows: gas for domestic and industrial use; liquid fuels for road, sea and air transport; and bituminous residues that are normally used in road construction. Basic distribution facilities include pipelines, storage tanks, pumping stations (which really belong to the transportation or industrial sectors) and standard service stations that supply fuel to automobiles and small vessels. Damage assessment for service stations involves procedures mentioned earlier in this section.

d) Other facilities

This item includes buildings used for administrative purposes and recreational centers for company personnel. Such facilities are common to all sectors, and their damage assessment requires the techniques described for the housing and human settlements sector.

9**2. Indirect losses**

Indirect losses include the additional cost of providing oil and oil derivatives to meet energy requirements during the rehabilitation of affected facilities. It also includes net income not received during the same period, including the additional costs mentioned above.

a) Temporary supply of oil and oil derivatives

The estimate of costs to temporarily provide oil products must be based on the magnitude and nature of the damage sustained and on the duration of rehabilitation work. These two factors would have already been determined by the time the assessment of direct damage is made. Then the demand for oil and oil derivatives needed to replace lost production capacity and for the reconstruction process should be estimated. This calculation should take into account the extent to which the disaster may affect demand among leading residential, commercial and industrial consumers, all types of functioning automobiles and other vehicles, and roads that have to be constructed or repaired with bituminous material. New demand, in terms of volume and type of oil derivatives, should be estimated based on the above factors and with due consideration for the diminished purchasing power of affected consumers.

Once new demand levels are projected, the analyst should consider alternative means for fulfilling that need. Several possibilities may arise, depending on the availability and location of existing resources and the facilities available for transportation and transfer. Tanker trucks should be used to meet small demands near deposits. Active and abandoned pipelines can be used for pumping fuel across greater distances, or new pipelines can be built if their investment can be justified. Finally, tanker ships, such as those commonly used commercially to ship oil and oil derivatives around the world, can be pressed into service using either existing facilities if available or, in their absence, provisional installations adapted to emergency situations.

The corresponding costs should be estimated based on the above considerations and after the most economical and feasible alternative has been selected. In any event, this type of activity falls within the transport and communications sector, and it should be recorded as such. Data on capital and operational costs must be calculated, including the purchase cost of oil and oil-derivatives, which is easily obtained since they are sold at international prices.

b) Other indirect losses

10 As explained in greater detail in the section on the electrical sector, indirect effects due to lost income can be quantified in the following manner. The net income is determined for the post-disaster scenario. Note that gross income is expected to fall, whereas costs should rise as the greater cost of temporary supply is included. Results will very probably be negative. Then the net income that the company under study would have obtained if the disaster had not occurred is determined. This information can be obtained from the files or forecasts of the oil company itself. In those rare cases when records are not available, estimates can be made based on the files of similar companies. The algebraic difference between net income under normal conditions minus income in the post-disaster situation should yield the total indirect loss, which would be equal to the profit not received by the oil company as a result of the disaster.

3. Breakdown of damages and losses

As in the case of the electrical sector, direct damages and indirect losses are broken down, on the one hand, into domestic and foreign currency for purposes of the balance of payments and on the other, into public and private - sector costs for purposes of national accounts. In the case of the oil sector, the macroeconomic effects might be significant, especially in those cases where the country affected is a net oil and oil derivatives exporter, requiring a much more detailed analysis of the indirect and macroeconomic effects by the energy sector specialist, in close cooperation with the macroeconomics specialist.

4. Effects on employment and on women

The electrical and oil sectors employ a limited number of personnel in view of their relatively high dependency on technology, so these industries tend to have limited repercussions on personal income levels following a disaster. For the very same reasons, no significant differential impact on women is expected to arise from these sectors.

5. Impact on the environment

This section describes the main links between assessing damage to the energy - sector and assessing that to the environment. The energy specialist is also referred to the chapter on environmental assessment included in Volume Four of this Handbook.

Some environmental changes related to water resources have a negative impact on hydroelectric power generation. Leaving aside droughts, whose effects are obvious, other disasters –such as floods and landslides– may also affect the availability and quality of water. Landslides can result in the obstruction and diversion of water flows that feed dams, thus affecting resource availability for electrical generation. Floods can increase the silting rates of reservoirs, giving rise to a reduction in their storage capacity and, therefore, in their useful life.

When a watercourse is diverted, river training works are required, and their expenditure should be recorded as indirect damages in the energy sector. A decision to omit such works for technical or financial reasons will compromise the future energy production capacity of the hydropower plant and should be registered as direct damage; this can be estimated as the present value of the difference in net income flows resulting from the disaster. When silting reduces the useful life of a reservoir, the approach is very similar, and damage should be estimated as the present value of the lost net income flow associated with the years of lost production. It must be pointed out, however, that estimation of silt deposition volumes requires lengthy field surveys whose results will not be available at the time of the assessment.

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Oil is a non-renewable natural resource that is a part of a country's natural capital. Oil spills of significant proportions are registered as direct damage in the energy sector based on market prices. The environmental assessment seeks to identify the share of these damages that correspond to the contribution of natural capital, isolated from contributions of human capital and other assets such as infrastructure, machinery and equipment. This contribution may be estimated using an economic rent concept that, in the case of underground assets, has methodological difficulties. It will therefore be necessary to use estimates from other sources.¹ To avoid double accounting, these estimates will not be included in the damage overview.

Oil spills and the release of other toxic substances into the environment are another usual effect of disasters. Breakage in oil pipelines is one of the major risks associated with earthquakes. Toxic substances (such as sulphur and other compounds associated with geothermal production) may also be released when their collection and disposal systems are damaged or destroyed.

¹ For example, Kunte et al. "Estimating National Wealth: Methodology and Results", Discussion Paper, the Environment Department of the World Bank, Washington, 1998.

In general, these direct damages and indirect effects are accounted for either in the energy or in the transport sector. The environmental specialist should work closely with other members of the assessment team to ensure appropriate damage accounting, especially of the expenses required to restore the environment to pre-disaster conditions.² In cases where natural areas are affected by these events, the environmental specialist will most likely be put in charge of calculating those damages. The preferred method for assessing these damages is the restoration cost method described in the chapter on environmental assessment in Volume Four.

An example of how the assessment of the energy sector should be carried out is presented in the following appendix.

APPENDIX VII

DAMAGE TO THE ENERGY SECTOR CAUSED BY THE MARCH 1987 EARTHQUAKE IN ECUADOR

A major disaster occurred in Ecuador in March 1987, caused by a series of earthquakes whose epicenter was located in the northeastern region of the country. The disaster badly affected the living conditions of low-income population groups, destroying their homes and basic services. More serious damage was inflicted on the transport infrastructure used by key sectors of the economy, undermining the country's ability to export and generate foreign currency.

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1. Electrical sector

The earthquakes, mudslides and floods caused direct damage to some power plants, national-grid transmission lines and two hydroelectric power plants that were still under construction. They also caused indirect losses because the supply of had to be temporarily suspended in some cities, hydroelectric production had to be replaced with higher-cost energy produced in thermal plants, and the unit operational costs of thermoelectric power plants rose due to an increase in the cost of the transportation of diesel fuel.

The repair of power plants and electricity transmission systems was estimated on the basis of costs provided by the companies that operate them, as were the costs to repair and rebuild the camps at the power plants under construction. Direct total damages were estimated at 3.5 million dollars.

Indirect losses included increased costs in the dams that were under construction, higher electricity production costs because thermoelectric plants were used, and lost revenue at utility companies. Total indirect losses were estimated at 0.3 million dollars.

² Although the energy specialist may have assessed direct and indirect damages caused by these events, environmental restoration measures may be under the responsibility of institutions not directly related to this sector. In such a case, it is likely that these expenses would not have been accounted for in the energy sector especially if the solution to the problem depends on the environmental authorities.

Therefore, total damages and losses sustained by the energy sector as a result of the disaster were estimated at 3.8 million dollars. Since most of the equipment and materials to be replaced are not produced domestically, a negative effect on the balance of payments was projected of 2.2 million dollars .

Table 1
SUMMARY OF DAMAGE AND LOSSES CAUSED BY THE EARTHQUAKE IN ECUADOR 1987

Item	Damage, millions of dollars			Effect on the balance of payments ³
	Total	Direct	Indirec	
Total	3.80	3.51	0.29	2.18
Production infrastructure	0.13	0.13		---
Lines and substations	0.12	0.12		---
Construction work camps	3.26	3.26	--	2.18
Greater generating costs and reduced income from billing	0.29		0.29	--

Source: ECLAC, based on official figures.

2. Oil sector

Although no physical damage was detected in the oil-producing wells, mudflows and floods cut the Trans-Equatorial oil pipeline that links the production area located in Lago Agrio to the refinery and oil and oil derivatives export terminal located in Esmeraldas. The flow of crude from the eastern area, which accounts for 99.6% of national oil production, was interrupted, and approximately 100,000 barrels of oil were spilled. The breaks in the pipeline, of different diameters, covered a total length of approximately 78 kilometers, and civil works at some pumping stations were damaged.

Direct damage to pipelines and related works and the value of the oil spilled was estimated at a cost of 120 million dollars. Reconstruction of the pipeline, following the same route of the previous one to facilitate matters, required a four-month period, and indirect losses were much greater than direct damages (see Table 2).

These indirect losses had domestic and external repercussions on the country's economic performance. They refer to a significant decrease in foreign currency earnings from oil exports throughout the reconstruction period, and to higher costs incurred to meet the domestic demand for oil derivatives.

Domestically, higher costs were incurred to supply liquid gas to the capital city of Quito, owing to the broken pipeline, as alternative routes and means with higher operational costs were used. In addition, the internal demand for oil derivatives had to be met by combining a temporary loan of such products from Venezuela and the building of an alternative pipeline to Colombia in order to extract limited amounts of oil, which were then transported by ship to the Ecuadorian refinery at Esmeraldas.

Oil exports had to be suspended until the pipeline was rebuilt, even though temporary loans from Venezuela and Nigeria made it possible to comply with some foreign commitments. Losses were thus spread over a longer time period than that required for the reconstruction of the pipeline.

3 The value of the components that will have to be imported because they are not produced domestically.

In addition to the above, the Ecuadorian State Oil Corporation (Corporación Estatal Petrolera Ecuatoriana – CEPE) sustained losses due to the reduction in domestic consumption of gasoline, and refineries (private and state) processed a lower volume of oil in their facilities. This loss of profits increased indirect losses caused by the disaster.

In sum, the earthquake caused direct damage to the sector's infrastructure totaling 121.7 million dollars and indirect losses worth 766.7 million, resulting in total damage and losses of 888.4 million dollars. Moreover, the country's balance of payments was affected with a negative impact of around 815 million dollars, caused by the fall in oil exports and the increase in imports required for domestic consumption.

Table 2

DIRECT DAMAGE AND INDIRECT LOSSES CAUSED BY THE 1987 EARTHQUAKE IN ECUADOR

Item	Damage, millions of dollars			Effect on the balance of payments
	Total	Direct	Indirect	
Total	888.42	121.67	766.89	815.6
Reconstruction of pipelines, pumping stations, and cost of oil spilled	121.67	121.67	--	66.0
Greater costs for internal supply	90.17	--	90.17	87.3
- Investment in pipeline to Colombia	17.05		17.05	
- Greater transportation costs	15.69		15.69	
- Cost of replacement oil	54.56		54.56	
- Greater liquid gas transportation costs	0.87		0.87	
- Greater transportation costs of derivatives to Oriente	2.00		2.00	
Export losses	662.30	--	662.30	662.3
- lost exports	64.27		64.27	
- charges of loaned oil	19.60		19.60	
Lost profits	14.28	--	14.28	--
- Reduced consumption	5.27		5.27	
- Reduced processing in refineries	9.01		9.01	

Source: ECLAC, based on official figures.

The March 1987 earthquake caused 892 million dollars in total damages and losses to Ecuador's energy sector. Of this amount, only 14% are direct damages to the sector's infrastructure, and the remaining 86% are indirect losses. In addition, the disaster had an 818 million dollar negative impact on the balance of payments, mainly due to the inability to meet oil sale commitments abroad. This aggravated the economic situation in the country at the time, which had already been weakened largely as a result of a previous fall in world oil prices.

II. DRINKING WATER AND SANITATION

A. INTRODUCTION

In light of the region's epidemiological indicators, mortality rates are closely related to infectious diseases that, to a large degree, depend on the quality of water consumed and on access to adequate sanitation services. When this situation turns critical during disasters, post-disaster activities must concentrate on rehabilitating services that might otherwise constitute sources of epidemics; special attention must be paid to water quality, sanitary removal of excreta and solid waste management.

The search for solutions to restoring water supply must take into account each potential resource, its capacity, its proximity to a drainage system and all potential causes of chemical contamination.

Under normal circumstances, inadequate human waste treatment methods negatively affect the health of the population. In a disaster, removal and treatment of human waste acquires increased relevance in avoiding the transmission of infectious diseases, and it constitutes a public health priority.

Damage in this sector depends not only on the intensity of the disaster, but also on vulnerability, a special characteristic of each component of the entire system. To put it differently, a disaster of a given magnitude and type may cause very different damage to different systems, or to different components of one system. The vulnerability of a system basically depends on four factors: its geographical location, the quality of engineering design, the quality of construction (including technology, equipment and materials used) and the quality of facility operation and maintenance.

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Most components of water and sanitation systems require proper operation and systematic maintenance over time; their absence would make the systems less resistant to damage and would hinder repairs when a disaster occurs. In turn, good operating and maintenance require effective organization, with workshops, spare parts and drainage layout plans, which significantly help to size, assess and repair more quickly and at a lower cost any damage produced by a disaster. Hence, operating and maintenance departments of affected systems will be a key source of information for the assessment team.

B. ASSESSMENT PROCEDURE

The assessment process requires, as a prerequisite, the definition of the area affected by the disaster. The water and sanitation specialist must also determine what institutions are involved in the sector and the role each of them plays. The water and sanitation sector requires a multi-disciplinary and holistic approach to the dialectic relationships among its component elements. At the same time, each service or subsector (water supply, sanitary sewage disposal and solid waste collection and disposal) requires special assessment procedures. The assessment team must obtain information on the individual policies to be applied in each of the subsectors, as well as each one's degree of development.

On the technical level, the assessment team should collect basic information and detailed maps of the affected systems, which will be essential for the necessary field evaluations and verifications. After the assessment is concluded, it should be possible for the water and sanitation specialist to prepare a table showing the most accurate and summarized information on damage and losses to the subsystems, as indicated in the following table.

Table 1
DAMAGE AND LOSSES IN THE WATER AND SANITATION SECTOR
(In thousands of dollars)

Component	Damage			Sector		Effect on the balance of payments
	Total	Direct	Indirect	Public	Private	
Total						
Water supply systems						
Urban systems						
Infrastructure						
Rehabilitation expenses						
Diminished utility revenue						
Higher production costs						
Rural systems						
Infrastructure						
Rehabilitation expenses						
Waste water disposal systems						
Infrastructure						
Rehabilitation expenses						
Diminished utility income						
Higher production costs						
Rural systems						
Infrastructure						
Rehabilitation expenses						
Wells and latrines						
Solid waste systems						
Rehabilitation expenses						
Diminished utility revenue						

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C. INFORMATION REQUIREMENTS

The water and sanitation specialist should strive to obtain all available information on the subjects listed below as a basis for the assessment.

1. Drinking water supply systems

- Organization of the entire water supply subsector: service provider utilities, municipalities and regulatory and governing bodies;
- Pre-disaster water service coverage levels (urban and rural);
- Breakdown of the population served by collective and individual systems (such as collective water systems, individual wells, multi-family systems);
- Identification of the urban and rural systems affected by the disaster;
- Determination of whether the disaster affected the water supply treatment process and identification of any resulting need for additional chemicals/reagents or equipment;

- Characteristics of the systems affected by the disaster:
 - *Population served before the disaster (number of domestic connections, average levels of water consumption, etc.);
 - *Water supply rates, existing subsidies, billing collection effectiveness, etc.;
 - *Pre-disaster production levels;
 - *Water production capacity after the disaster; and
 - *Estimated time required for rehabilitating all affected systems;
- Blueprints of all affected systems;
- Characteristics of damage sustained by all affected systems:
 - *Description of damage sustained by different equipment/components of the affected systems;
 - *Construction techniques and materials used in the systems' components; and
 - *Accessibility to different components in the affected systems;
- Temporary organization of the water and sanitation service provider utilities, to meet population's needs until full services are re-established;
- Identification of measures undertaken to rehabilitate systems; and
- Costs of materials, construction, equipment, chemicals/reagents and other inputs required for the rehabilitation and reconstruction of systems.

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2. Wastewater disposal systems

- Organization of the sewage disposal subsector: service provider utility, municipalities, etc;
- Coverage levels of the urban and rural sewage disposal and sanitation systems prevailing before the disaster;
- Breakdown of the population served by collective and individual systems (latrines and septic tanks);
- Identification of urban and rural systems affected by the disaster;
- Characteristics of the systems affected by the disaster;
 - * Population served before the disaster (number of household connections, etc.);
 - * Sewage disposal rates, subsidies and billing effectiveness (include any link to billing for drinking water);
 - * Pre-disaster wastewater treatment levels;
 - * Post-disaster treatment capacity; and
 - * Estimated time required to rehabilitate affected systems.
- Characteristics of damage to the affected systems:
 - * Description of damage to equipment/components of the affected systems;
 - * Construction techniques and materials used in sanitation systems; and
 - * Accessibility of affected systems;
- Temporary organization of water and sanitation utilities for meeting the population's needs until services are re-established;
- Identification of measures required for the rehabilitation of systems; and
- Costs of materials, construction, equipment, chemicals/reagents and other inputs needed for system rehabilitation and reconstruction.

3. Solid waste collection and disposal

- Description of existing local utility for the collection, processing and final disposal of solid domestic waste;
- Characteristics of damage to the service's assets (trucks, access roads to towns and dumps, etc);
- Geographical coverage and beneficiaries of these services before the disaster;
- Identification of measures required for the rehabilitation of affected systems; and
- Costs of materials, construction, equipment, chemicals/reagents and other inputs needed for system rehabilitation and reconstruction.

D. SOURCES OF INFORMATION

The water and sanitation specialist should enlist the assistance of all institutions and sources that may have basic information required for the damage and loss assessment, such as the following:

- Governing bodies and regulatory institutions, and water and sanitation services provider utilities:
 - *Municipalities responsible for operating and maintaining water and sanitation systems and services; and
 - *Ministry of health, housing or public works, when they have jurisdiction over the water and sanitation sector;
- National or departmental associations of municipalities.
- Water and sanitation utilities whether national, state, municipal, private, mixed or community managed:
 - *Their annual reports in particular;
 - * Local water and sanitation management boards,
- Non-governmental organizations (NGOs) that usually construct rural water systems (CARE, Save the Children, OXFAM, Catholic Relief Services, etc.) and then transfer the systems to be self-managed by the community itself;
- National Chapters of the Inter-American Association of Sanitary and Environmental Engineering (AIDIS);
- UNDP, UNICEF and PAHO/WHO reports on the state and coverage of water and sanitation services, normally issued once every ten years.

E. DESCRIPTION OF DAMAGE

1. Direct damages

The water supply and sanitation specialist should be able to describe all direct damages sustained by the systems that make up the sector, as described below.

Drinking water supply systems. Ascertain the following:

- Damage to infrastructure and equipment of urban systems, preferably broken down by component;

- Damage to infrastructure and equipment of rural systems, preferably broken down by component; and
- Loss of stocks (chemicals, stored water, spare parts, other assets).

Wastewater disposal systems. Obtain the following information:

- Damage to infrastructure and equipment of urban systems, preferably broken down by component;
- Damage to infrastructure and equipment of rural systems, preferably broken down by component; and
- Loss of stocks (chemicals, spare parts, equipment, etc.).

Solid waste disposal systems. Ascertain the following information:

- Damage to infrastructure and equipment;
- Damage to access routes to facilities or dumps for final waste disposal; and
- Impact on waste disposal dumps.

2. Indirect losses

Here again, the water and sanitation specialist should obtain all information relevant for estimating indirect losses in the three subsectors.

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Drinking water supply systems. The following data would be required:

- Activities related to rehabilitation (distribution of water by tanker truck or other means, purchase of equipment and machinery, repairs, changes in water treatment processes, use of materials and inputs kept in stock ready for rehabilitation efforts, personnel overtime);
- Reductions in potable water output (as it relates to intake, treatment, storage or distribution facilities);
- Reduction of operational costs due to the partial functioning of systems;
- Increase in potable water production costs;
- Losses due to income not received (water not billed, suspension of service, etc.); and
- Insurance coverage.

Wastewater disposal systems. The following information is essential for estimating indirect losses:

- Activities related to rehabilitation (network inspection work, acquisition of equipment and machinery, repairs, etc.);
- Reduction in wastewater treatment capacity;
- Increases in wastewater treatment costs;
- Losses due to income not received; and
- Insurance coverage.

Solid waste disposal systems

- Losses due to income not received
- Decrease in solid waste collection and disposal costs; and
- Insurance coverage.

F. QUANTIFICATION OF DAMAGE AND LOSSES

1. Direct damages

To facilitate their quantification, we suggest that damages be grouped in accordance with the following components.

- First damage should be identified by type of system:
 - Potable water supply systems;
 - Wastewater disposal systems; and
 - Solid waste disposal systems.
- Second within each city and individual system, damage should be grouped by component or subsystem; for example, for the potable water supply system of a city:
 - Water intake facilities (intake A, intake B, etc.);
 - Pumping stations (station 1, station 2, etc.);
 - Water treatment plants (plant 1, plant 2, etc.);
 - Main lines to storage tanks;
 - Storage tanks (tank A, tank B, etc.);
 - Distribution networks; and
 - Other components, to be defined in each case.

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The total damage to the potable water system of each city may then be obtained by summing the individual component damages.

A list of damage sustained by each subsector (water supply, wastewater disposal, and solid waste disposal) should be prepared, with a breakdown by materials, equipment or facilities. A procedure similar to the one described below could be adopted:

- A summary description for each damaged component should be made including its main elements, the type of damage and the approximate amount of work or material affected, in appropriate measurement units. For each damaged component, the following should be indicated:
 - Type of work and/or materials required;
 - Unit construction prices at replacement value (UP); and
 - Cost of repairs, estimated as a percentage (R%) of the unit reconstruction price described above.

- The estimate of the percentage (R%) to which facilities, materials or equipment may be damaged should be obtained directly from the service provider utility, or on the basis of a weighted estimate that would take into consideration whether the facility, material or equipment can be repaired or partially reconstructed or must be totally reconstructed or replaced. If there is a chance that the damage can be repaired, the cost of the damage should be estimated as a percentage (R%) of the total cost of said facility, material or equipment. If the facility has to be totally rebuilt or replaced, R should be taken to be 100%.
- The initial R% can be based on estimates provided by personnel from the utility that is responsible for each system, or from other sources, but the final figures adopted should be those calculated by the water and sanitation specialist on the assessment team on the basis of information he/she collected during the field mission.

In addition, one must take into account the cost of demolition, dismantling and debris removal in the manner described below.

- For each system component (identified in accordance with the above recommendations), a determination must be made as to whether reconstruction or repair will be required prior to demolition, dismantling or debris extraction. If such prior work is needed, an indication should be made of the approximate amount of work or material to be demolished and removed, in the appropriate unit of measurement, which as far as possible should be the same unit as the one used to quantify the damage to this item.
- A description should be made of the work or main activities considered part of demolition, dismantling and debris removal (adopting a single unit price for each item).
- The degree of difficulty and costs involved in work and materials should be taken into consideration. For example, distinctions should be made between the “demolition” of a reinforced concrete storage facility and the “dismantling” of asbestos cement pipes, whose joints can be much easier to take apart and which could be partially recovered and re-used.
- If an accurate estimate of prices under this heading is not possible, a criterion similar to that indicated in the previous point should be adopted, where the cost of “demolition and removal of debris” should be expressed as D% of the unit price. However, D% is not necessarily equal for each item, owing to the varying degrees of difficulty of demolition or removal.
- If part of the material can be recovered as a result of demolition or dismantling, whether for re-use by the same utility or for sale, its remaining value should be estimated as a percentage (V%) of the unit price of said material when new. These results should be deducted from demolition, dismantling and debris-removal costs.

If the disaster directly affects the warehouses or other storage facilities where spare parts, chemicals, reagents and water tanks are kept, this must be taken into consideration. The water and sanitation specialist should consider all available sources to ascertain the amount and unit prices of the materials in question.

Unit prices to be used in damage assessment can usually be obtained from recent feasibility studies or from the unit price lists normally used by the utility that provides the affected services. In this case, the date the lists were made should be ascertained so that, when necessary, adjustments for inflation can be made. The unit prices to be used can also be based on estimated unit prices derived from direct surveys or suitable local sources. “Comparative unit prices” available for the region that can also be used for comparisons with the two previous points, and used instead of them, when necessary.

No matter where the list or estimate of unit prices is obtained, it should include the labor content and the percentage of domestic and imported materials as a percentage of total unit prices. This will make it possible to distinguish the total amount of direct damage, the value of imports and their corresponding effect on the balance of payments.

22 Water supply, wastewater disposal and storm drainage systems include a wide array of facilities, materials and equipment. The cost of some of these facilities may easily be estimated on the basis of unit price lists. Such is the case of water pipes, whose unit price can be expressed in linear meters either for the simple purchase of the pipe or for their complete installation. The costs of other types of facilities (e.g., potable water treatment plants) that include components employing varied technologies and prices should be estimated based on a total price for the facility.

2. Indirect losses

Indirect disaster effects usually last throughout the rehabilitation and reconstruction period or until facilities return to normal operation. These effects include the water supply utilities’ income shortfall (owing to reduced billings as they supply less water) and to increased water leakage from yet-to-be- repaired pipelines. They also extend to the higher operational costs the utility must assume to ensure the temporary provision of water until normal service is re-established. The negative impact on health should also be included. An agreement should be reached with the health sector specialist in order to avoid duplications or omissions in this regard.

a) Drinking water supply systems

i) **Rehabilitation of normal operations.** Depending on its magnitude, a natural disaster may affect very large geographical areas that might include cities of various sizes, towns and rural areas. The random nature of the disaster and its ramifications might require a broad range of activities for rehabilitating services; these involve costs that should be included as indirect damage (in addition to the repairs of direct damage). These rehabilitation activities include the following:

- Pipeline repairs, using plastic patches or jackets, provisional by-pass pipelines and also works to divert flows away from holes in order to avoid losses of water in damaged pipe networks;

- Use of existing stocks or reserves of equipment, materials, chemicals and reagents;
- Increased chlorine concentration in already chlorinated water, with temporary functioning of chlorination facilities for untreated water and for storage tanks and preventive chlorination in deep and shallow wells in both urban and rural areas;
- Use of other existing potable water sources such as the deep wells of private factories, businesses or sports facilities (this calculation includes water connections to the network, the supply of power to pumping equipment, etc.);
- Temporary conversion of existing water storage facilities –such as swimming pools, factory and business storage tanks– as well as fiberglass and plastic tanks to store and distribute drinking water;
- Temporary use of tanker trucks or other vehicles pressed into service for delivering drinking water to the population;
- Activities required to implement, when necessary and possible, temporary rationing of drinking water in the network;
- Increasing water pressure in the network to avoid contamination of the potable water, which might be essential even in the event of increased water leakage;
- Preparation and delivery of instructions to the population on preventive measures for the use of water (boiling, for example), rationing timetables, tanker truck routes, water distribution points, etc; and
- The cost of alternative means for the public to acquire/purchase water (e.g.; the premium paid for such water, health problems).

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ii) **Estimating the cost of rehabilitating services.** Rehabilitation activities vary greatly owing to the wide range of potential disasters and the peculiarities of each region. In order to simplify matters, one should begin by grouping these costs into a limited number of categories:

Increased labor costs. This item includes any increases in costs of professional, technical, administrative and manual labor employed in rehabilitation operations, over and above the normal payroll levels. They may be estimated as follows, bearing in mind that the affected utility company would already have some estimates on the matter:

- Prepare a simplified list of personnel categories employed in this type work, indicating their unit cost in each category (person-months, person-days, as applicable);
- Estimate the “number of person-units” in each category that will be required for the rehabilitation operations during the entire period they are expected to last; and
- Multiply these values and add the subtotals to obtain total losses.

Estimated cost of works and repairs. This point includes any costs not included under the previous item. It should include all materials, transport, fuel and so forth, that may be used in works and repairs. Only a fraction of the total value of equipment, machinery, pipe and valves installed on a temporary basis is to be included in these estimates, which would include an amortization estimate (r%), whose value will depend on the use made of such elements during the rehabilitation.

A list of the main material works performed should be made, including a summarized description of each work or other material costs; the approximate volume of each work, materials or item; the unit price of each; and any overhead expenses and profits (where appropriate).

Estimated cost of using water sources or intake works not belonging to the public water utility. This involves expenses that have to be paid in accordance with special agreements with third parties.

Use of tanker trucks for drinking water distribution. Tanker trucks may deliver water in order to alleviate problems in those areas where the disaster disrupted normal service. Estimates should take into account such factors as the capacity of trucks engaged to deliver water and the rates charged per delivery.

iii) **Reductions in drinking water production.** The disaster may reduce the volume of water tapped from any source for treatment and delivery to the public. This shortfall may be the result of direct damages such as:

- A drought-induced decrease in water availability;
- Contamination of water sources; and/or
- Damage to intake facilities, pumping stations or other equipment.

- 24 iv) **Reductions in the distribution capacity of drinking water systems.** Damage to major pipelines that convey drinking water to cities or intermediate facilities (such as treatment plants, pumping stations, storage reservoirs, etc.) may impair the system's overall delivery capacity. Damage to secondary pipelines or to distribution networks may partially affect drinking water distribution capacity. Damage to domestic connections and/or interior networks of buildings, houses, factories, markets and the like may curtail local delivery capacity. Damage to pumping stations may also affect the system's total or partial water conveyance capacity.

v) **Reductions in the regulation and storage capacity of drinking water systems.** Any reduction in water regulation capacity diminishes the ability of a system to meet demand over time and avoid losses to water sources. This item includes any damage to a system's regulation and/or storage capacity, as well as damage to minor, industrial, commercial or domestic reservoirs.

vi) **Reduced consumption of drinking water.** Consumption in affected cities and towns may be partially or totally curtailed by the supply constraints noted above (e.g., direct damage to the potable water supply system) and/or the displacement of the consuming public. Should the sanitary quality of the water be undermined, residents would be forced to boil water. Obviously, a fall in supply and/or demand would reduce utility billings and revenues.

vii) **Increased water production costs.** These usually result from an elevation of existing water intake points or the need to draw on alternative sources; an increase in the daily volume of water production to compensate for leakage in either the main pipelines or in the distribution networks; and/or higher power and other input costs.

viii) **Lost income** (water not billed, temporary suspension of supply, etc.). To estimate the extent to which billings have declined (or the probable reduction in water sold to consumers in cities and towns located in the disaster area), one must determine the main factors responsible for the shortfall.

ix) **Impact on public health** because water flows have become inadequate, inconsistent or of inferior quality. The impact on health, particularly on that of children and the elderly, can vary and should be analyzed under the health sector.

b) Wastewater disposal systems

Three main types of indirect losses may be sustained, by wastewater disposal and storm drainage systems.¹

i) Increased health-risk levels and reduced quality of life. Apart from the fall in the level of hygiene that may result from the lack of sufficient drinking water, the lack of sanitary or storm drainage may pose significant public-health risks for the following reasons:

- Wastewater disposal systems cannot be used in those areas that do not have a potable water supply because water is essential to flush away excreta and other waste;
- Breaks and blockages in the sewage disposal network will likely result in wastewater flowing to the surface of streets, increasing the risk of disease and epidemics either by direct contamination or by the action of vectors.
- Any problems at wastewater treatment plants might further pollute the water resources into which effluents are discharged; and
- The risk of flooding increases when rainwater drains are damaged.

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ii) Rehabilitation involves a wide array of activities including pipe repairs, the laying of provisional pipelines or drains and the digging of drainage ditches. These also may include maneuvers involving valves, gates and other facilities to divert flows from wastewater or rainwater pumping stations and to expel wastewater that has flooded plants, chambers or ditches. The cost of maneuvers and rehabilitation works for sewers should be estimated in the same fashion as drinking water.

¹ In some instances, the same system is used to evacuate both wastewater and storm runoff. In other localities, separate systems exist.

iii) Decreased income from wastewater billings. How the disaster affects billings for wastewater disposal services depends on how billing is normally done in the affected cities. Where the charge is computed as a percentage of water supply billings, losses should be estimated using the following formula:

I_t = total decrease in water supply billings in the city;
 $a\%$ = percentage (%) overcharge in water supply bills included to pay for the wastewater disposal service;
 $s\%$ = percentage of population having both water supply and wastewater system in relation to the total population having water supply connection.

Hence, the decrease in billing for wastewater disposal services will be obtained as

$$\Delta f_a = I_t \times (a\%) \times (S\%).$$

However, there could also be an additional segment of the population that cannot make use of the wastewater disposal service because it is broken. This loss might be estimated as an additional percentage ($Z\%$) to the one indicated above, in the following manner:

$$\Delta f_a = (Z\%) \times (\text{Normal billing for waste water disposal service})$$

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When the cost for use of the wastewater disposal service is a flat rate for connecting to the system, the loss in billings can be estimated by applying a percentage to the overall billing for the city.

Given:

F_a = total monthly billing for wastewater disposal service for the entire city;
 $F_a/30$ = average daily billing;
 $g\%$ = estimated billing percentage not charged due to the disaster;
 p = length of the period during which irregular or no service is provided, in days

Then:

$$\Delta f_a = (g\%) \times p \times (F_a/30), \text{ in US\$/period}$$

Where no charge is made for wastewater disposal service, the utility's revenues would not be affected.

G. MACROECONOMIC EFFECTS

All items, information, background and procedures necessary to assess the water supply and sanitation sector's impact on the country's macroeconomic performance are described below.

1. Effects on gross domestic product

a) Reduced output

This refers to the reduction in production of water that occurs from the time the disaster occurs until normal production capacity is restored. The lost production should be estimated as the shortfall in utility revenues resulting from the reduced volume of water billed to the users, plus any increase in the cost of providing the service because of water produced that fails to reach consumers due to leaks in networks or other reasons.

It is possible to estimate how long it will take to resume normal supply and billings in light of the scale and characteristics of direct damages and the financial, repair and reconstruction capacity of the corresponding water-supply utilities.

A table should be prepared for each affected city and/or utility, the following data:

- The reduction in drinking water volumes billed each month to users from the time of the disaster until service is likely to be normalized;
- Any variations in average rates charged to the public for the volume of drinking water delivered;
- The shortfall in the utility's monthly revenue (the difference between pre- and postdisaster billings); and
- Any added costs associated with the population having to acquire water by other means.

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b) Projected sector performance prior to the disaster

The macroeconomic specialist may have access to such data for the entire country and the affected area. However, in Latin America and the Caribbean, the only such projections normally to be found involve the volume of water tapped, treated or lost through network leaks in urban areas, so it might be more practical to estimate the sector's GDP based on the volume of water billed to consumers. We recommend that the water and sanitation specialist, in close cooperation with the macroeconomics specialist, carry out the following tasks;

- Analyze national accounts and consult all institutions overseeing the sector in order to obtain, where possible, data on changes in GDP for the previous five years, together with a forecast by the corresponding officials on the sector's expected performance for the current year had the disaster not occurred; and
- Analyze any changes in the sector's strategies that would allow the service to be restored and further developed.

2. Effects on gross investment

These include the following three items:

a) Projects under execution and other projected investments that must be suspended or postponed, or whose funds must be reassigned to meet disaster-related needs

This information should be summarized in a table identifying the main projects affected and the investment envisaged for each one. Finally, an estimate is to be made of the expected reductions in investment for each project as a result of the disaster, in the current and succeeding years.

b) Losses of stock

A table must be prepared showing losses of stock (such as water stored in reservoirs and/or in storage tanks, chemicals and reagents for the treatment of water), as well as losses of materials and spare parts stored and/or available in facilities that were under construction.

c) Financial requirements for repair or reconstruction

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The background for developing this item will mainly come from the direct damage lists and assessment, providing total and itemized costs for the damage. Based on that information, a table comprising the following information can be prepared:

- A list of affected works, broken down by systems, subsystems and main facilities and indicating the overall cost of the damage to each one. This list should separately identify works in the different cities and companies (if there is more than one responsible for the service in the same city), as well as for rural areas.
- A forecast of investment needed in the succeeding years for repairing said damages. The forecast should reflect the relative urgency of the respective works, the engineering capacity of the country and/or utility, and possible sources of financing. Special regard should be given to weighing the relation between national project execution capacity and new construction demands, and domestic capacity for covering the post-disaster surge in demand for reconstruction-related inputs vis-à-vis imports.

The water and sanitation specialist should make special reference to any expected requirement and capacity limitations for reconstruction and repair and make appropriate recommendations (as time and information limitations permit).

3. Effect on the balance of payments

The water and sanitation specialist should provide basic information on indirect losses so that the macroeconomic specialist may calculate the effects of the disaster on the current account. The information listed below should be included.

a) Decreased exports of goods and services

Since drinking water is very rarely exported, this item would not normally be taken into consideration. However, if an affected country normally exports engineering services related to the sector, the increased internal demand determined by the disaster might reduce or eliminate the export capacity for such services over a period of time. The reduced value of this export should be expressed as follows:

$M\$s$ = decreased value of exports of services, in a given period;
 MsO = decreased value of exports of services, in the year of the disaster;
 $Ms1$ = idem for the year following the disaster; and
 $Ms2$ = idem for the second year following the disaster

Therefore: $M\$s = (MsO + Ms1 + Ms2)$

b) Increased imports

To estimate the value of this item, imports required for rehabilitation and reconstruction of direct damages should be taken into consideration. Such imports may be obtained from the summation of the imported components of direct damage estimates made previously.

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To estimate increased imports, the following procedure might be used:

Given:

Idd = increased imports as a result of direct damage;
 $Idd0$ = idem, during the year of the disaster;
 $Idd1$ = idem, during the year following the disaster; and
 $Idd2$ = idem, during the second year (etc.) following the disaster
 (as applicable)

Thus: $Idd = Idd0 + Idd1 + Idd2$

c) Donations

This item includes international assistance for the sector consisting of donations in kind, equipment, materials and machinery. Although these donations will probably occur in the period immediately after the disaster (year 0), there should be an indication of whether donations are expected in the following years.

d) Reductions in international debt servicing

If a reduction in interest payments has been granted by creditors, due note should be made of it under the year in which it occurs.

e) Insurance and re-insurance

Increasingly, both the assets and revenues of the water and sanitation sector are domestically insured against disaster risks. Should that be the case, estimates must be made of insurance payments due after the disaster, as well as the expected amounts of reinsurance to be received from abroad, since these will have an effect on the country's balance of payment.

4. Effects on public finances

A disaster might disrupt public finances in several ways, as described below.

a) Decline in tax revenues due to lower production of goods and services

If water and sanitation billings are subject to taxation and if, utility revenues decline as a result of the disaster, the corresponding fiscal or municipal revenue will also diminish. To estimate these tax revenue shortfalls, due consideration should be given to the following:

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- Declines in revenues due to decreased billing and water losses; and
- Information on the percentage (p%) and value of said taxes as estimated by the utilities.
- The value of lower taxes may then be estimated as follows:

$$M_i = M_{i0} + M_{i1} + M_{i2} = \text{lower tax revenue in years 0, 1 and 2.}$$

b) Decline in public utility revenues

Lower billings due to a decreased supply of drinking water, as indicated above, results in decreased revenues for the affected utilities.

Thus:

$$M_f = M_{f0} + M_{f1} + M_{f2} = \text{Lower billing for years 0, 1 and 2.}$$

c) Increased outlays for reconstruction and damage repair

Information required to estimate this effect on public finances should be obtained from tables included in the previous example on gross investment.

Let: M_{gi} = higher outlays in reconstruction investment.

Then: $M_{gi} = M_{gi0} + M_{gi1} + M_{gi2} = \text{idem, year 0 + year 1 + year 2}$

5. Effects on prices and inflation

Damage caused by the disaster may have a bearing on changes in the prices of water and construction materials required to repair damages in the sector. This would depend on several factors, including the magnitude of the disaster and the amount of damage caused.

a) Possible change in the price of water

The cost of water may vary as a result of a disaster for several reasons. Among them:

- Water production costs may vary owing to the need to change the place or type of water resource intake, the type or types of treatment plants or the conveyance or elevation of the water, or because of a drawdown in groundwater levels;
- If the resulting difference in costs compared to those before the disaster is absorbed by the utility through subsidies, there should be no effect on the price to the public.

Information on these matters should be provided by the water utility. However, it is unlikely that they could be reasonably certain of the exact impact on pricing so soon after the disaster, so the analyst must also make possible trend projections. If the cost increases as a result of the factors indicated above, the relationship between the new cost per cubic meter and the previous cost, or the expected variation in the new price to the public, should be indicated.

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b) Possible effects on the price of construction materials.

Heightened demand for construction materials in this sector and throughout the economy in the wake of a disaster is likely to exert significant pricing pressures. Therefore, the assessment team as a whole should analyze the situation concerning a possible increase in construction material prices.

From the point of view of the water and sanitation sector, it would be useful to have an estimate of the increased demand for the main materials that will be involved in repair and reconstruction during the years following the disaster. The specialist should also develop an idea of the domestic production capacity, its relation to the increased demand and the capacity to import said materials. In addition, consideration should be given to possible price controls adopted by the government.

H. OTHER EFFECTS

1. Possible effects on employment

As in the case of the energy sector, the growing use of technology and equipment implies that the water and sanitation sector employs a limited amount of personnel for the operation of its networks. A disaster is thus likely to have a very limited effect on employment and personal income in this sector. In fact, personal income of utility enterprises may actually increase during the rehabilitation period due to the payment of overtime.

The water and sanitation specialist should work in close cooperation with the employment specialist of the assessment team to arrive at the overall effects that the disaster may have on employment and income, ensuring that figures for the water and sanitation sector are duly included and not duplicated in the latter's global estimates.

The following paragraphs describe possible effects on employment for the sector.

a) Effects due to replacement of facilities and infrastructure

32 Since availability of drinking water is essential to the population, destroyed facilities and other infrastructure must be replaced as quickly as possible. The technology and design of the new facilities might require a different number or type of personnel for purposes of operation and maintenance. Any differences in employment arising from technological changes must be duly noted.

b) Effects occurring during the reconstruction and repair stage

Employment requirements during the emergency phase fall outside the scope of the assessment described in this Handbook. However, any of the following possible impacts on employment during the reconstruction process should be indicated:

- Employment levels could remain unchanged if reconstruction efforts absorb workers who were laid off when projects begun prior to the disaster were cancelled or suspended;
- Employment could increase if normal projects and activities are maintained while additional workers are hired for reconstruction and rehabilitation projects; or
- The employment scenario could be mixed, with only a percentage of pre-disaster development projects being canceled or postponed.

The disaster may have an impact on the investment decisions of government officials and the drinking water utilities, so the water and sanitation specialist should obtain the relevant information from these institutions for estimating any variations in employment for years 0 1, and 2 (if reconstruction works require more time, more years must be added).

These employment projections must be consistent with the time-frames and investment projections made earlier with regard to reconstruction requirements.

2. Differential effects on women

Any damage to drinking water systems in rural and marginal urban areas has a differential effect on women, who generally bear the burden of obtaining water for household consumption where no domestic water connections are available.

When a family or community well or spring is rendered useless as a source of drinking water because of contamination or silting, women are forced to dedicate greater time and effort to obtaining water from more distant locations, thus increasing their reproductive workload.

The section on the differential impact of disasters on women in Volume Four of this Handbook explains in detail how this increase in reproductive work can be estimated through field surveys. The water and sanitation specialist should work in close cooperation with the gender specialist in making such estimates.

3. Impact on the environment

Any change in the availability or quality of the water resource used by the drinking water supply system constitutes an environmental modification that has negative effects on people's health and well-being. The same is true of sanitation problems caused by disruption of wastewater disposal and solid waste management systems. While the chapter on environmental matters in Volume Four deals with these issues, the estimation of related costs falls within the purview of the water and sanitation specialist, who should coordinate with the environment specialist to ensure that all the relevant information is effectively obtained and that there is no double accounting.

APPENDIX XVIII

ESTIMATING LOSSES IN THE DRINKING WATER AND
SANITATION SECTOR CAUSED BY THE JANUARY 13, 2001,
EARTHQUAKE IN EL SALVADOR²

On January 13, 2001, an earthquake that registered 7.6 on the Richter scale struck El Salvador. Its epicenter was located off the Pacific coast, approximately 100 kilometers southeast of the city of San Miguel. The quake was felt throughout El Salvador and in some neighboring countries, but the regions suffering the greatest damage were the departments of Usulután, La Paz and San Vicente.

The earthquake, which was followed by numerous and powerful aftershocks, took a significant toll on the poorest segments of the population, especially their housing, basic services, education and access to healthcare. All productive sectors and the country's basic infrastructure were affected.

Most of the information required for evaluating the water and sanitation sector was provided by the Administración Nacional de Acueductos y Alcantarillados (ANDA), the Pan - American Health Organization/World Health Organization and the Ministry for Public Health and Social Services.

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1. Drinking water and sanitation

Prior to the earthquake, El Salvador supplied potable water to 86.8% of the urban population (2,951,565 inhabitants) and to 25.3% of its rural residents (830,130 inhabitants). Sanitation services were available to 85.9% of urban residents (2,727,160 inhabitants) and to 50.3% of the rural population³⁻⁴.

The above service breakdown implies overall (urban and rural) coverage of 60.4% for drinking water and 68.3% for sanitation. Such services are supplied by ANDA, municipal governments and the health ministry, as well as local and international NGOs that are largely focused on covering demand in rural areas.

a) Drinking water supply

According to ANDA damage reports, water storage tanks and distribution systems were the components of urban service networks hardest hit by the quake. The extent of damage varied widely, ranging from cracked walls, weakened support structures (beams, towers) and the settling of surface-level facilities.⁵

² ECLAC, *El terremoto del 13 de Enero de 2001 en El Salvador. Impacto socioeconómico y ambiental*, Mexico City, February 2001.

³ Dirección de Planificación, *Boletín estadístico* N°21, ANDA, San Salvador, 1999.

⁴ OPS/OMS – UNICEF, *Evaluación global de los servicios de agua y saneamiento – Informe analítico*, San Salvador, July 2000.

⁵ ANDA, *Información preliminar de agua potable y alcantarillado sanitario a nivel nacional – Ocasionado por el sismo del 13/01/2001*, San Salvador, 2001.

In the San Salvador metropolitan area and other regions serviced by ANDA, varied degrees of impact on flows from wells and pumping stations were reported. Meanwhile, weakened slopes and the resulting landslides led to ruptured water mains, especially near hillsides, and water supply was suspended for days or even weeks before the breaks were repaired. There were also reports of damage to electric equipment and water treatment plants, but in most cases these were repaired and service was reestablished quickly.

Unfortunately, it was not possible to obtain information on the extent to which services were suspended or impaired in municipalities not covered by the ANDA system.

Thirty-two out of approximately 400 rural drinking water systems reported varying degrees of damage that largely consisted of the uncoupling or breaking of water mains, especially near inclines and ravines or in areas where the land was otherwise unstable. Where the walls of shallow wells were damaged, they had to be cleaned or alternate water sources had to be found. According to estimates, approximately 10 400 household shallow wells were in need of repair or reconstruction after the quake, and most of those were to be found in the countryside or in marginal urban neighborhoods.

According to data from ANDA and other relevant institutions, roughly 500 000 urban residents temporarily lost access to drinking water; that is equivalent to 15% of those normally receiving this service. In rural areas, 9.1% of service recipients, or 75 626 inhabitants,⁶ were similarly affected.

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During the emergency stage, tanker trucks were used to deliver properly chlorinated water, and portable water treatment equipment was deployed to areas where normal service had been affected. By February 8, tanker trucks had distributed 18 968 cubic meters of drinking water.

In addition to the emergency measures cited above, ANDA, municipal authorities and local water boards went to work immediately of the quake to restore damaged networks, prioritizing those supplying urban areas and those rural systems for which the cost of repairs could be immediately covered by local water boards or ANDA. Work was strictly focused on restoring service as quickly as possible, so some repairs further magnified vulnerability, especially along ravines where there were reports of landslides. Some inclines that were left unstable by the quake remain highly susceptible to future tremors, human intervention and rainfall that could inflict damage as great or greater than that of the original earthquake.

b) Sanitation systems

While ANDA reported no damage to wastewater disposal facilities and municipalities have yet to publish any relevant information in this regard, the assessment team assumed that any damage would become apparent over the course of sanitation-system operations. Depending on where sewerage lines ran, and their proximity to water mains, there was a remote possibility that potable water could have been contaminated.

⁶ Gerencia de Sistemas Rurales, *Informe de daños a sistemas rurales de agua potable hasta el 29/01/2001*, ANDA, San Salvador, 2001.

Latrines, which are the main form of sanitation system in the rural sector and in marginal urban communities, sustained considerable damage or were totally destroyed, especially in the hardest hit areas. According to data on the number of rural dwellings that were destroyed and the extent of such sanitation systems in the countryside, it was estimated that approximately 63 000 latrines were damaged.

c) Solid waste disposal

Municipalities provide solid waste collection and disposal services. During the field visits it was impossible to obtain any information concerning the state of these services. COMURES (the National Council of Municipalities of El Salvador) intends to collect information on this matter sometime in the future.

2. Estimated damage and losses

Direct damage to drinking water and sanitation systems was estimated at 13.1 million dollars. Indirect losses –which involve greater expenses and fewer revenues for the sector’s utilities– were estimated at 3.3 million dollars. Total damages and losses thus reached 16.3 million dollars. The international community provided one million dollars in emergency assistance. Meanwhile, the temporary suspension of service implied estimated savings of approximately 525 000 dollars in state subsidies to ANDA (see table 1 below).

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Table 1

SUMMARY OF DAMAGE AND LOSSES IN THE SAN SALVADOR EARTHQUAKE OF JANUARY 2001
(Thousands of US dollars)

Item	Total damage	Direct damage	Indirect losses	Impact on balance of payments
Total	16,340.0	13,062.0	3,278.0	8,500.0
1. Urban systems	8,363.0	6,200.0	2,163.0	5,000.0
- Infrastructure damage ⁷		6,200.0		
- Emergency relief ⁸			663.0	
- Low income			1,500.0	
2. Rural systems	7,977.0	6,862.0	1,215.0	3,500.0
- Damage to rural water systems		362.0		
- Emergency relief ⁷			1,215.0	
- Damage to shallow wells		500.0		

⁷ Reconstruction costs include those for repairing public sector buildings damaged by the earthquake.

⁸ Includes an increase in operational expenses.

III. TRANSPORT AND COMMUNICATIONS

A. INTRODUCTION

This chapter concentrates on assessing the impact of a disaster on the transport and communications systems of a country or region with special reference to road transportation and its infrastructure, the hardest hit subsector in the events analyzed by ECLAC in the last 30 years. We also take up the telecommunications and coastal infrastructure subsegments.

A handbook of this type obviously cannot anticipate all possible types of damage to the transport and communications sector. Infrastructure and services vary greatly from country to country, as do the characteristics of the phenomena that cause disasters. Therefore, this Handbook describes the general assessment procedure for the sector, which the transport and communications specialist must adapt to the specific conditions of each case.

The general rule that the assessment only be conducted after the emergency stage proper is especially important for transport and communications. During the emergency phase, counterpart personnel for the assessment are usually busy trying to solve more urgent problems and have yet to amass the necessary information. In addition, a completely valid assessment is not possible until the natural phenomenon has concluded. An earthquake assessment must contemplate the effects of aftershocks, which can provoke considerable damage of their own. The impact of protracted flooding –as in the case of the El Niño phenomenon in countries located along the Pacific coast of South America– cannot be fully gauged until floodwaters have completely receded.

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Once the assessment mission has begun, the transport and communications specialist must meet his/her counterparts from the country or region where the disaster has occurred –including representatives of civil defense organizations or their equivalent, the ministry of public works or transportation, the affected municipalities, etc.– in order to carry out the following tasks:

- Obtain detailed information on the characteristics of the disaster;
- Determine the geographic scope of damage to the sector;
- Provisionally identify the administrative agency or agencies responsible for transportation and communications infrastructure, whether public or private; and
- Make initial contact with officials of local organizations who may be able to assist in the collection of the basic information essential for impact assessment.

Periodic coordination meetings of the assessment team can allow the transport and communications specialist to obtain necessary information from other team members and ensure that there is no evaluation duplication between sectors. This last point is of special importance in the transport sector, whose use by agriculture and industry increases the threat of double accounting.

Field visits to affected areas are essential. While it is important to consult official aerial photographs to get an initial idea of the scope of the damage (these are usually available before the assessment begins), on - site inspections are key to a thorough analysis. When confronted by such obstacles as collapsed bridges, eroded roadbeds and flood waters, analysts may have to complement overland visits with an overflight of less accessible areas in a helicopter or light plane.

B. QUANTIFICATION OF DAMAGE

1. The road network and ground transportation

38 The road network is often the sector's primary disaster-damage recipient. National or local authorities make at least a preliminary evaluation of direct damages to road infrastructure. These usually include cost estimates of emergency repairs to re-establish minimum communication and access; the rehabilitation of infrastructure to pre-disaster conditions or to the state it should have been in if proper maintenance had been provided; and improvements, such as new detours or the construction of new bridges with longer spans than those destroyed. The costs of works under the first two categories are directly related to direct damage assessment, whereas those under the last category are important for formulating reconstruction projects, an issue with which the transport and communications specialist will become involved after concluding the damage assessment.

The analyst must closely scrutinize any official direct-damage estimates issued by national or local authorities. Such numbers may be incomplete or not entirely reliable, for several reasons:

- Impassable sections of road may have prevented the detection and assessment of damage to other strips of road located further upstream;
- Local or national authorities may have overestimated the value of damage in an attempt to increase reconstruction funding;
- Inadequate maintenance may have led to considerable pre-disaster damage;
- The estimates may have overlooked some reconstruction costs, such as the value of the full-time labor for which relevant institutions and organizations had already budgeted;
- National authorities may not have taken into consideration damage to locally administered or privately concessioned infrastructure; and
- Such estimates almost never take into account damage to privately owned vehicles.

Therefore, the transport and communications specialist must first check that official estimates contemplate all the necessary elements and correctly quantify the costs. Table 1 provides information on unit costs for some typical assets.

Table 1

TYPICAL VALUES OF CERTAIN UNIT DIRECT COSTS

Item	Price in USD
New light utility vehicle (average)	10 000
New small car (average)	10 000
New truck, rigid frame (average)	60 000
New urban bus (average)	100 000
New inter-urban bus (average)	150 000
New bicycle (average)	150
New motorcycle (average)	500
Km. of dirt road, flat/undulating land (reconstruction)	10 000
Km. of dirt road, undulating/mountainous land (reconstruction)	20 000
Km. of hardcore road, flat/undulating land (reconstruction)	50 000
Km. of hardcore road, undulating/mountainous land (reconstruction)	75 000
Km. of paved road, one lane each way, flat/undulating land (reconstruction)	100 000
Km. of paved road, one lane each way, flat/undulating land (reconstruction)	150 000
Km. of paved road (rehabilitation)	25 000
Km. of hardcore road (rehabilitation)	15 000
Km. of dirt road (rehabilitation)	5 000
Mend potholes in paved road, one lane each way, per km.	2 500
Bailey bridge, 20 meter span, CIF importing country	200 000
Reconditioned 2500 hp diesel locomotive	750 000
Reconditioned 750 hp diesel locomotive	450 000
New railway truck	85 000
New railway carriage	500 000
Km. of railway, one way (reconstruction)	100 000
New light aircraft 500 000	500 000
50-seat propeller-driven aircraft, new	15 000 000
150-seat turbine aircraft, reconditioned	20 000 000
20-metre fishing boat, wood, new	65 000
25-metre fishing boat, metal, new	200 000
Grader, reconditioned	75 000

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Experience has shown that national or local authorities do not assess indirect losses (the largest damage component in the transport and communications sector), as they are mainly focused on determining the affected road network's reconstruction needs.

Disasters usually provoke a reduction in the volume of incoming and outgoing transportation. In this regard, it is not sufficient to estimate the difference between pre-disaster and post-disaster transportation unit costs and then multiply it by normal transportation volume; this would overestimate indirect disaster costs. Neither is it valid to multiply the difference in the volume of post-disaster transportation, because this would underestimate indirect damage.

The transport and communications specialist should revise and update the direct damage estimates made by local authorities, but when it comes to estimating indirect losses, the specialist must practically begin from scratch and conduct his/her own assessment.

Indirect loss assessment requires the quantification (in monetary terms) of the increase in the operational costs of vehicular traffic on a road network damaged by a disaster, as compared to costs under a normal situation. Such a calculation must also contemplate any surplus lost due to trips not made because of impassable roads or the heightened cost of driving on them.

The following generic formula may be used for this purpose. (Note that this formula does not take into consideration some factors that, time permitting, should be included in the calculation, such as the effect of taxes on vehicular operating costs.)

$$\text{Indirect cost} = \int_{q_1}^{q_0} p \cdot dq - p_0(q_0 - q_1) + q_1(p_1 - p_0) \quad (1)$$

where:

q_0	=	the volume of traffic under normal conditions;
q_1	=	the volume of traffic after the disaster;
p_0	=	the cost of transportation in normal conditions; and
p_1	=	the cost of transportation after the disaster.

- 40** How this formula is applied depends on the circumstances, especially on the availability of basic information. It should usually be applied for each affected section of road, even if this might involve some inconsistencies such as differences between the volume of traffic on one section and that of the next or the previous one. Note that transportation costs should include the cost of travelers' personal time.

Typically, sufficient information is available to apply the formula separately for light vehicles, buses and trucks.

The usual procedure to be applied is as follows:

1. In consultation with local road engineers, estimate the pre-disaster international roughness index (IRI) of each affected section of the road;
2. Estimate the pre-disaster operational costs for each affected section by type of vehicle as a function of the IRI, referring for example to the results of similar applications made by applying the World Bank's Highway Design Model in the country affected by the disaster or in another comparable country;
3. Repeat the two previous steps to estimate the post-disaster IRI and operational costs for the same sections of the network;
4. After obtaining data for pre-disaster traffic volumes and estimating the elasticity between the traffic volume and operational costs, use a simple mathematical formula to calculate post-disaster volumes: $q = kpe$ (where q = traffic volume, k = a calibration determinant and e = elasticity).

Data on pre-disaster traffic volumes for each section of the network can be obtained from traffic surveys or by consulting local road engineers familiar with the normal volumes by road and vehicle type. The transport and communications specialist must usually estimate elasticity based on his/her own experience. However, when information is available on post-disaster traffic volumes (q_1 in formula 1), they may be calculated on an approximate basis.

5. Finally apply formula 1.

Calculations made using formula 1 must be supplemented with additional estimates when one or more of the following situations arise:

- A bridge has totally collapsed. In such instances, one must take into account potential costs associated with trucks and their crews being left idle on either side of the river, the operation of either ferries or a railway shuttle established on a parallel bridge, and trucks having to take long detours along alternative routes.
- Truck or bus traffic is replaced by air transport. In this case, the above formula can still be used, with the difference that the values for q_1 and p_1 must refer to a non-overland means of transport.
- Traffic is detoured over longer routes. Costs include the longer distance to be covered and the higher unit cost of transportation per kilometer.

Clearly, the sector specialist must estimate how long the road network is likely to remain in disrepair. National authorities are often too optimistic in this regard, so the transport and communications specialist must make his/her own estimations, taking into account the productivity of the available machinery and labor, the length of the affected road network and a reasonable rehabilitation schedule. The indirect cost estimate must be expressed in current values while applying the corresponding discount rate to future costs.

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Indirect costs are normally lower for other transport subsectors than for roads. Although the same concepts described above can be used for assessment, additional considerations apply. For example, a part of normal railway transportation interrupted by a natural disaster will probably be diverted to other means of transportation, such as roads, whereas another part will simply not take place. When applying formula 1 to such a case, p_0 costs refer to the railroad, and p_1 costs to the alternate means of transportation. Rail-freight charges, especially those of private companies, are normally higher than short-term marginal transport costs.

The values of p_o must reflect the freight paid by customers; the loss to rail customers can then be estimated by applying formula 1. One must include the loss sustained by the railway company (roughly equivalent to foregone profits), which can be estimated by means of the following formula:

$$(q_0 - q_1)(f_0 - c_0) + q_1(c_1 - c_0) \quad (2)$$

Where

- f_o = the value of the freight charged, by unit of traffic;
- c_o = the marginal cost of transportation before the disaster, by unit of traffic; and
- c_1 = The marginal cost of transportation after the disaster, by unit of traffic.

In normal circumstances $p_o \neq f_o$, because the values for p_o include additional cost elements charged to rail users, such as that of truck transport to the rail station.

It is impossible to include in this Handbook examples of calculations needed for every conceivable scenario, as each disaster has its own peculiarities. The transport and communications specialist must use his/her criteria and experience to adapt the above guidelines to each case.

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The growing trend toward the privatization of transportation in Latin America and the Caribbean adds dimensions to the damage assessment. The management of the busiest communications infrastructure –highways, ports, railways, etc.– are increasingly in the hands of private companies, who sometimes also own the facilities and equipment.

These companies are usually more reluctant than government institutions to provide basic information, unless they realize that by doing so they help themselves to obtain financial support. Moreover, corporate offices are often much more geographically dispersed than those of ministries or other official bodies, making on-site visits all the more challenging.

In the event of damage to concessioned transport infrastructure priced by tolls, losses may accrue to both users and concessionaires. Formula 1 can be used in principle to estimate losses to users, inserting values for p_o and p_1 that reflect tolls paid by users instead of the marginal or direct cost of providing the service. To estimate the losses of the concessionaire, formula 2 can be used.

2. Water and air transport and their infrastructure

Analysis of the air and water sub sectors is essentially no different from that of the road sub sector, especially where direct damages are concerned. However, indirect loss analysis must be adapted for the specifics of each subsector. The problems involved in assessing indirect losses for water and air transport are similar to those of the telecommunications subsector, which we take up later in this chapter.

A disaster's impact on roads often expands the operational costs of trucks and cars, but air, rivers and seas are often essentially unchanged. Water levels may rise above normal, but this does not necessarily affect the operational costs of vessels. Specific water or air routes might be canceled in the wake of a disaster, but if not, operational costs will probably be the same as before. Exceptions include cases in which diminished river levels require the use of smaller water craft or a damaged landing strip calls for smaller aircraft, thus expanding unit transport costs. Formula 1 can be directly applied in such cases.

When water or air transport is canceled owing to adverse weather or damage to terminal facilities, it is sometimes very difficult to determine the values of p_1 , that is post-disaster unit transport costs, including components paid by users in addition to the fare or freight rate, such as the value of personal time devoted to the trip. The resulting shortfall or absence of transport on some routes can reduce total transport costs. (If there is no post-disaster transport, the value of q_1 is 0, meaning that the component $q_1 (p_1 - p_0)$ in formula 1 is also 0, as long as the value of p_1 is not infinite.) The specialist must estimate this diminished cost while taking into account that some cost elements, such as part of depreciation, labor and administration, would not change. It must be remembered that some transport that does not take place during or immediately after the disaster may be undertaken afterwards, demanding an intensified schedule of service to compensate for demand not fulfilled during the paralysis.

In the case of a cargo shipment delayed for some weeks by the temporary lack of transport services, cost p_1 should include interest, which can be estimated quite easily, as well as the cost of deterioration of goods, which can be more difficult to quantify. The failure of cargo to arrive on time can have high-cost consequences, such as increased human suffering when medicines fail to reach their intended destination or factories grinding to a halt owing to a lack of materials. The sectoral specialists must assess these consequences. In the case of delayed personal trips, cost p_1 must include an estimate of the cost of the inconvenience involved. Only surveys—which are never possible as part of disaster assessment—can satisfactorily quantify this inconvenience, but one must try. In the following section, we propose a method for making such a calculation, albeit one that is not intellectually satisfying.

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3. Telecommunications

The telecommunications sector contemplates the full range of telephony services including fax and Internet and e-mail access. In principle, it also extends to radio and television broadcasting. As with other sectors, we divide damages into direct and indirect categories.

We approach the telecommunications sector in a similar fashion as we would the transportation industry, especially concessioned transport, since most telecommunications enterprises are now privately owned. Direct costs may involve the value of repairing losses to three categories of infrastructure: the installations from which telecommunications are managed; transmission or broadcast facilities; and equipment used to send or receive messages. The first of the above categories comprises administrative offices, repair facilities, laboratories, and so forth. The second category consists primarily of antennas and cable lines and theoretically extends to the air through which short wave signals carry wireless phone messages. The third category includes wired and mobile handsets, computers and fax machines.

Estimating the costs of repairing services and replacing all three types of infrastructure following a disaster basically consists of an exercise in accounting similar to one that would commonly be applied to road and rail transportation. Nevertheless, it is necessary to take into account the very fast-paced process of technological innovation that swept the telecommunications sector in the last years of the twentieth century and continues into the twenty-first century. This progress translates into premature obsolescence and accelerated depreciation for some types of infrastructure, thereby implying that the value of infrastructure in company balance sheets may be exaggerated.

Clearly, if a flood were to wipe out an analog switching station or destroy a phone with a rotary dialer, the real cost of replacement would be quite low, since those units have been superseded by digital technologies. It is thus important to assess the current market value of infrastructure at the time of the disaster. In the event that there is no market in the affected country for specific types of infrastructure, the analyst must make an assessment based on a realistic evaluation of the economic life of each type of equipment, together with a profile of the average age and nature of the equipment or installations that have been destroyed.

Sometimes it is not economically viable to repair the damaged equipment since the next generation of devices provides enhanced productivity at a lower cost. Instead of contemplating the replacement cost, in such situations the analyst could use the following formula:

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$$(\text{cost of new equipment}) \times (\text{productivity of the old equipment}) \times (\text{productivity of the new equipment})^{-1} - (\text{the residual value of the analog equipment}).$$

Nevertheless, each case is unique, so the analyst must bring his or her own professional experience and judgment to bear.

As for indirect damages, disasters tend to generate costs for both users and service providers just as in the case of privatized railroads. It is usually relatively easy to quantify the losses of service providers using formula 2. As we explain below, however, it is much more difficult to estimate losses to users.

Telecommunications systems can be easily damaged, thereby frustrating any efforts to place a phone call or to send a fax or e-mail message. In that case it is very difficult to assign a value to p_1 when using formula 1. Here we encounter parallels between the telecommunications industry and air or water transportation (to be analyzed in the second section of this piece) in that it is simply impossible, at any cost, to establish contact between some points immediately after a disaster.

Thus the average value of the calls, faxes and e-mail messages that could not be made as a result of the disaster must be estimated. In practical terms, the specialist will lack conceptually satisfactory formulas for making such an assessment and may simply value the call at twice the amount the user would normally pay.

This involves trying to guess the value of the call in a totally arbitrary manner, but better options are rarely available. Ideally, one would have access to industry studies identifying the nature of the demand for phone calls, faxes and e-mail messages, and then link the number or volume of calls with the relevant charging rates.

Occasionally one may encounter data that makes it possible to estimate the function of call demand (phone, e-mail, etc.) based on the communications response of catastrophe victims. For example, we determine that in a given city some q_0 calls are normally made from either fixed-line or wireless calls at a price of p_0 to the user. During a disaster phase when neither wired nor wireless service is available, those same citizens will make only q_1 calls from emergency booths set up by the army at a price of p_0 , plus a wait of three hours. An estimate of the value of the personal time of local inhabitants would make it possible to calculate and apply the value of p_1 in formula 1. Each case is different, requiring that the analyst decide what methodological variant is most applicable.

Telecommunications services are normally suspended for a relatively brief period. That is particularly true today, now that underground or elevated cable lines can be at least temporarily replaced by wireless alternatives.

4. Coastal infrastructure

This part of the chapter focuses on the impacts of a disaster on coastal infrastructure. Its relevance is of greatest significance for small island developing states (SIDS), where natural phenomena such as hurricanes take a can a very high toll, but it also applies to the coasts of the continental mainland.

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Coastal zones represent a disproportionately large part of the landmass of SIDS. To make matters worse, most infrastructure is often concentrated in the coastal zone: urban developments (including critical infrastructure such as hospitals, police stations, and utilities); industrial centers; port infrastructure; marinas; fishing communities; and tourism developments, among others. In the Caribbean, and in particular in the Lesser Antilles, the islands generally are either volcanic in origin or composed of coral caps. The mountainous terrain of volcanic islands generally means that most development is confined to a relatively narrow strip along the coastline, whereas on coral caps development tends to be spread more evenly across the island landscape. In both instances, coastal roads tend to serve as the main links between urban centers and tourism developments. Damage to such infrastructure can be devastating to the small island economies, producing significant hardship during the first year or more of rehabilitation.

a) Information requirements

i) Coastal roads. The following minimum information should be obtained:

- The agency or agencies that deal with the construction and/or repair of main and arterial roads;
- The physical extent of damaged roadways;
- The actual volume of roadway material removed or destroyed;

- The importance of the damaged road to the road network linking towns and rural centers;
- The volume and types of traffic that would typically use this road;
- The extent of any utilities that may have been damaged as a result of the disaster;
- Knowledge of the general topography and seabed bathymetry of the area;
- Knowledge of the hurricane wave conditions that may have caused the damage;
- Knowledge of building code requirements and the criteria for design of coastal infrastructure (in the Caribbean the 1-in-50-year hurricane cycle is typically used as the design criterion for non-essential infrastructure); and
- An estimation of the need for coastal defense works in the rehabilitation exercise.

ii) **Harbors and marinas.** In response to a growing tourism sector, many harbor facilities have been developed to handle the cruise shipping industry in the Caribbean basin. In some instances, cruise - ship facilities have been combined, in the same port area, with other general port operations. Marinas catering to the yachting fraternity have also appeared across the region. These marinas vary greatly in size and can offer berthing facilities for vessels ranging from dinghies to mega-yachts. Harbors or marinas are often sheltered against waves by breakwater-type structures unless located in a naturally sheltered site.

46 Data requirements in the assessment of damages to these facilities include the following:

- Knowledge of the agency in charge of port operations;
- Plans or maps showing the pre-disaster layout of facilities;
- The physical extent of the damage;
- An inventory of damage to specific equipment, if applicable;
- An inventory of damage to berthing structures;
- Knowledge of the hurricane storm-wave conditions leading to the disaster;
- General knowledge of the local seabed bathymetry;
- Rehabilitation/repair requirements, including the appropriate type of structure and the approximate quantities of materials involved;
- Availability of materials to be used in the reconstruction process; and
- Reconstruction needs for imported materials, labor and special equipment.

iii) **Beach and shoreline erosion.** The existence and preservation of beaches and shoreline is of paramount importance to the tourism sector and to a number of ecological systems. When a beach suffers massive erosion from tropical storms or hurricanes, infrastructure located near the beach is also exposed. Such infrastructure is usually tourism related, but it could also be residential or industrial. Non-beach shorelines may experience damage to seawalls and/or revetments. On the ecological side, beaches may often serve as nesting sites for endangered turtles. When massive beach erosion takes place, the displaced sand may smother offshore sea grass beds and/or coral reefs. Beach recovery occurs naturally, although it may have to be helped along in the rehabilitation process.

Damage assessment requires a variety of data:

- Knowledge of any set-back regulations required by the local environmental planning agency;
- Physical extent of shoreline damage;
- Volume of beach material lost and/or volume of shoreline eroded;
- General idea of the fate of the eroded material;
- General knowledge of local seabed bathymetry and prevailing coastal processes;
- General background of prevailing wave climate;
- Storm wave action that resulted in the shoreline damage;
- Appropriate types of rehabilitation strategies, including the “do-nothing” approach;
- Local availability of dredging equipment, or the need to import;
- Availability of quarried armor stone, which may be required in the construction of special structures to ensure future beach and/or shoreline stability;
- General knowledge of coral reefs and sea grass beds in the vicinity of the damaged shoreline; and
- Approximate evaluation of habitat loss.

iv) **Water intake and effluent outlet structures.** Many coastal areas and islands must extract drinking water from brackish or salt water due to a lack of adequate rainfall or ground water resources. In some places, desalination plants have been established that require inflows of brackish water and discharge a brine solution that is piped into the ground or out to sea. In addition, wastewater treatment at a municipal or project-specific level often involves discharging treated effluent into the sea. Wastewater that is effectively treated only at a primary level is often discharged through a deep-sea outfall, whereas wastewater that is treated to a secondary or tertiary level is occasionally discharged into the sea, but very often is recycled for irrigation. Damage to effluent-discharge or to water-intake structures can have serious consequences for a community, whether large or small, significantly affecting the community’s post-disaster health.

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In assessing damage to this type of infrastructure, the following information and data should be obtained:

- Knowledge of the local agency dealing with water and sanitation;
- The physical extent of the damage, either on land or on the seabed;
- The type and quantities of piping and/or other equipment damaged;
- The user base of the damaged facilities (e.g., municipal treatment plant serving a community or a desalination plant for a hotel);
- General knowledge of the hurricane-wave and surge conditions that would have led to the damage;
- General knowledge of the repair or rehabilitation works required;
- The local availability of materials needed to carry out the repairs; and
- Any need to import construction materials, specialized labor or special equipment in order to carry out the repairs.

b) Sources of information

The following institutions are valuable sources of the information required for the assessment:

- Public works departments and transport ministries;
- Public utilities;
- Port authorities;
- Surveying departments;
- Engineering regulatory institutions;
- Contractors;
- Quarry operators;
- Material suppliers;
- Hotel and tourism agencies;
- Water and sewerage agencies; and
- Environmental regulatory agencies.

c) Description of damages

i) Direct damage

Coastal roads

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- Damage to the road and sub-base;
 - Damage to any sea defense structures associated with the road; and
 - Damage to any utilities linked with the road.

Harbors and marinas

- Damage to any protective breakwater structures at the marina or marina entrance;
- Damage to berthing structures within the berthing area, including docks and wharves;
- Damage to specific equipment associated with the operation of the harbor or marina; and
- Damage to walkways and landside facilities or infrastructure associated with the marina.

Beaches and shorelines

- Volume of beach erosion;
- Damage to infrastructure in the back of beach area (including tourism infrastructure);
- Damage to utilities in the back of beach area;
- Damage to any existing shoreline protection works; and
- Loss of ecosystems habitat.

Water intake/effluent outfall pipes

- Damage to sections of intake or outfall pipes;
- Damage to anchors for pipes; and
- Damage to associated equipment and plant on the shoreline.

ii) Indirect losses

Coastal roads

- Loss of productivity as a result of people not being able to travel from rural to urban centers;
- Increased costs of transport as a result of commuters having to take alternative roads;
- Loss of income as a result of busses and taxis not being able to operate on the affected roads; and
- Possible loss of revenue from damaged utilities.

Harbors and marinas

- Loss of revenue from cruise ships that would have docked had there been no disaster;
- Loss of income from the support services associated with the operation of a harbor; and
- Loss of income from the provisioning services accorded to a marina facility,

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Beaches and coastlines

- Loss of income derived from the recreational value of the beach;
- Potential loss of income from hotels or other tourism - related interests, as a result of closure of these facilities following the loss of beach and incursion of water and waves; and
- Loss of sand - producing potential as a result of the smothering of critical ecosystem habitat.

Water intake/effluent outfall pipes

- Losses through income not received as a result of plant not being able to operate;
- Impacts on the health sector as a result of reduced sewage treatment capabilities; and
- Rehabilitation activities.

d) Quantification of damage and losses

i) **Direct damages.** In quantifying damage during the assessment process, the coastal infrastructure specialist must liaise with counterpart personnel from the local agencies involved in rehabilitation or repair work, or with agencies that are directly involved with the operation of the damaged facilities. This will facilitate a better estimate of the actual volume of material that was damaged or that needs to be brought in for repair work.

We recommend the following procedure to quantify direct damages to coastal roads, harbors and marinas, beaches and shorelines, and intake/outlet structures.

- Obtain up-to-date survey maps, at a scale ranging from 1:25,000 to 1:2,500, depending on the country in question;
- Determine the extent of the damage in conjunction with relevant local personnel and through field visits;
- Compute the actual volumes of road and sub-base damaged or destroyed;
- Estimate whether repairs are possible or whether total replacement will be required;
- Evaluate the repair/replacement costs, incorporating a factor to account for partial repairs, where applicable;
- Evaluate the cost of rehabilitation, using the cost of similar roadwork within the affected country or region using as a guide;
- Evaluate whether sea defense works will have to be incorporated into the rehabilitation procedure. If yes, then:
- Estimate the design wave height at the shoreline, and estimate the required size and volume of sea defense works required. and
- Estimate the requirement for repair and/or replacement of damaged utilities.

In addition to the items listed above, the following information should be sought for harbors and marinas:

- Obtain an up-to-date survey mapping of the harbor or marina area, preferably at a scale of 1:2,500;
- Obtain seabed bathymetric data for the affected area;
- Determine the physical extent of damage in conjunction with relevant local personnel and through field visits;
- Evaluate the actual damage suffered on an area-by-area basis (e.g., for breakwater and berthing areas, landside facilities, etc.);
- Estimate whether repairs are possible or whether total replacement will be required; and
- Estimate the cost of the replacement works based on discussions with local contractors and government agencies, and through evaluation of the cost of similar repairs elsewhere in the region.

For beaches and shorelines, quantification of damage should include the following:

- Volume of beach lost;
- Cost of replacing beach, probably through dredging of sand from an identified offshore reserve and placing this sand onto the damaged shoreline; and
- The need for any hard engineering structures to ensure shoreline stability, such as revetments and/or seawalls.

Finally, for intake and/or outflow structures, estimation of direct damage will include:

- Size of damaged piping;
- Length of pipe damaged;
- Associated infrastructure on land that may also have been damaged; and
- Anchoring systems for the pipe that may have been ripped out as a result of the disaster.

ii) **Indirect losses.** Indirect losses are likely during the assessment, repair and rehabilitation period. Quantification of these losses will require data from a number of sources as outlined previously, and it requires that the coastal infrastructure specialist target the proper sources of data within a fairly short period of time.

Information required for the quantification of indirect losses for the types of coastal infrastructure described includes the following items:

- Pre-disaster traffic flows along the affected roadway;
- Typical commuter fares, cost of petrol or diesel and typical number of commuters who would normally travel the affected route;
- Estimates of loss of income at affected utilities;
- Typical number of cruise - ship port calls prior to the disaster;
- Number of visitors typically expected during each cruise ship visit;
- Cruise shipping fees and average spending rate per visitor;
- Number of general cargo or container vessels that would ordinarily call at port;
- Tariffs or dues typically payable;
- Loss of revenue estimates from shipping lines;
- Number of yachts that would typically moor in the marina;
- Average berthing fees;
- Loss of revenue estimates from vendors who would provision the yachts;
- Number of vendors and water sports operators who would normally operate on a beach, along with loss of revenue estimates from them;
- Number of hotel or tourism - related staff that may be out of work while the rehabilitation works are being carried out, along with estimates of average earning rates;
- Loss of revenue estimates from water supply companies, where desalination intake lines have been damaged;
- Loss of income estimates from water and sewerage officials when effluent discharge lines have been damaged; and
- Cost of providing alternative water supply or sewage disposal.

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The above section includes and describes methodologies for estimating damage and losses to all types of coastal infrastructure and facilities many of which correspond to other sectors. For example, damage to drinking water and wastewater facilities should be included in the water and sanitation sector; damage and losses at tourism facilities –such as beaches and coral reefs– should be included in the environmental assessment. Special care should be exercised to avoid double accounting in such cases. Damage and losses sustained by roadways, landing strips and airports, harbors, piers and marinas, and so forth, should be estimated and accounted for under the transport and communications sector, however.

5. Other effects

As in other sectors, the transport and communications sector requires the breakdown of damage and losses into the public and private sectors, either because the treatment of rehabilitation and reconstruction might involve different modalities or because reconstruction may take advantage of the differential impact of the disaster on women, for example. Therefore, the transport and communications specialist must indicate the amount of direct and indirect damage for each sector.

Likewise, damage to transport and communications may have effects on the country's macroeconomic performance. The foreign sector might be harmed by increased imports of machinery, equipment and materials needed for reconstruction, as well as by exports not made due to the lack of connectivity or lost because perishable goods in transport at the moment of the disaster did not reach their destination in good condition. Even when machinery and other goods required for reconstruction are produced within the affected country, they normally include some imported components. In addition, the consumption of national resources for reconstruction may reduce exportable supply, as in the case of oil used in the rehabilitation stages after a disaster in an oil-producing country.

52 Public sector finances may also be affected -and fiscal deficits aggravated- by the revenue shortfalls arising out of diminished billing for public-sector services, decreases in the collection of service taxes and unforeseen spending for the emergency and rehabilitation works. All this information, estimated by the transport and communications specialist, must be delivered to the macroeconomics specialist for due consideration.

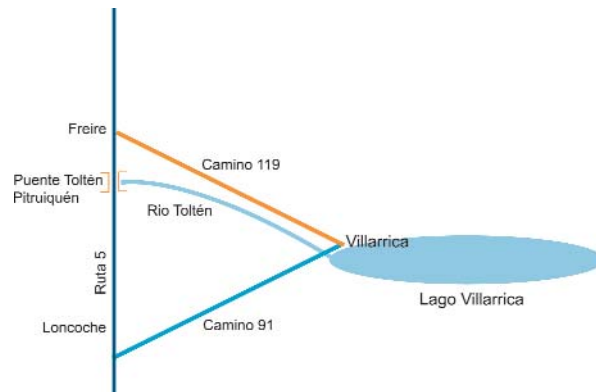
Unemployment and income loss within the sector may occur if transport and communications operations are suspended for long periods. One must estimate how much of the sector's services belong to women, as well as the percentage of potential employment and income losses corresponding to women (see the chapter on the impact of the disasters on women in Volume Four). The transport and communications specialist must ensure that the corresponding estimates are made in close cooperation with the employment and gender specialists.

The following appendix offers an example of how the methodology described above was applied to a typical disaster in the region.

APPENDIX XIX

ESTIMATES OF THE SOCIO-ECONOMIC COSTS
CAUSED BY THE WEAKENING OF A HIGHWAY BRIDGE
BY A FLOODED RIVER

Geographic location. The main Chilean highway, known as Route 5, runs a little more than three thousand kilometers from Arica through Santiago to Puerto Montt. Route 5 crosses the Toltén river, just north of the town of Pitruquén, 30 km south of the regional capital of Temuco and 677 km south of Santiago. The highway bridge over the river was built in 1935, many years before the route was paved, and its central section was weakened July 8, 1993, when the river broke its banks. The analysis summarized here in a simplified fashion was produced to estimate the socio-economic cost of the damage caused by the interruption to traffic and to determine whether a bridge inspection program should be carried out along Route 5 to minimize the risk of interruptions on other occasions.



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Description of the damage and its consequences. Immediately after the bridge was weakened, the police closed it to vehicular and pedestrian traffic. Drivers had to choose between canceling their trips and making a 46 km longer detour along a route we will call the Villarica road (see the schematic map above). Local traffic faced up to a 700% cost increase. However, most of the total costs arising out of damage to the bridge resulted from the longer distances traveled until a Bailey bridge was put in place on September 16, and the increased vehicle operating cost of normal traffic on the Villarica road after the heavy traffic diverted onto that alternative route deteriorated the quality of the pavement. Pedestrian traffic was handled by a shuttle-type train service on the (undamaged) railway bridge located a few meters to the west of the highway bridge. This service was maintained until a walkway was installed July 12.

Costs and benefits. Ministry of Public Works investments went toward the installation of the Bailey bridge; the definitive repair of the fixed bridge; and the Villarica road, which was the subject of an engineering study, emergency repairs (partially compensated for by lowering routine maintenance costs on Route 5) and reconstruction works. The increased costs to users were estimated in a breakdown, taking into account the following points:

- The costs of operating trains in the emergency period;
- The costs of post-emergency train service;
- The increased operating costs for vehicles making the long detour;
- Profits forgone due to cancelled long-distance trips;
- Greater operating costs for local traffic;
- Loss of profits due to local trips cancelled;
- Greater operating costs due to damage to the surface of the alternative road;
- Greater journey times for people who changed from buses to trains;
- Reduced operating costs for buses due to transfers to trains during the emergency; and
- Reduced operating costs for buses due to transfers to trains in the post-emergency stage.

Loss estimate. Lost profits were roughly estimated using the following formula:

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$$\int_{q_i^1}^{q_i^0} c_i \cdot \delta q$$

where: q_i^0 = volume of traffic before the disaster, i-type vehicles;
 q_i^1 = volume of traffic after the disaster, i-type vehicles;
 c_i = cost of traffic, i-type vehicles.

In general, it was assumed $q = k_i c_i^e$, where k_i is a constant (calibrated in each case), and e is a measure of elasticity, chosen in each case by the analyst to reflect the fact that the flow of certain types of vehicles, such as trucks on long-distance trips, would be more resistant to the greater costs arising out of using the alternative bridge than would other types of vehicles, such as cars, especially when they were not making trips related to economic activities. The elasticity coefficients chosen in the study summarized here varied between -1.00 and -0.25.

Strictly speaking, calculations should recognize differences between the costs perceived by travelers and those of resources consumed. The former differ from the latter because they include taxes, for example, and would consider that travelers often incorrectly interpret cost elements such as vehicle maintenance.

Results and conclusions. The present value of the socio-economic cost of the damage to the bridge, in December 1994 Chilean pesos, was estimated at 5.619 billion, comprising mainly the increased operating costs of long-distance road transport (29%), increased operating costs on the alternative route due to damage to the surface (24%) and progress in the reconstruction of the Villarica road (20%). The present value of an annual bridge inspection program would have been approximately 800 million pesos, and the cost of repairing the section of the bridge weakened by the water, had the damage been identified in time, would have been 250 million pesos.

In other words, socio-economic damage totaling 5.619 billion pesos could have been avoided with an investment of approximately 1.050 billion pesos- and that is without taking into account the other bridges along Route 5.

Therefore, we concluded that it would be very beneficial to establish a bridge inspection service.

Handbook

for Estimating the Socio - economic and Environmental Effects
of **Disasters**

Economic Commission for Latin America and the Caribbean
ECLAC

Section Four

Economic sectors

I. AGRICULTURE SECTOR

A. INTRODUCTION

1. General comments

Each type of disaster affects the agriculture sector in its own way.¹ The sector is usually most affected by those of a hydro-meteorological nature –such as tropical storms and hurricanes, floods, frosts and droughts– whereas the impacts of disasters of a geological nature –earthquakes, volcanic eruptions and tsunamis– may only be indirect or marginal.

The extent of impact defines the scope of the work of the agricultural specialist, but agricultural issues are intimately related to all other phases of the assessment process. Cooperation and constant consultation among all sectoral specialists is therefore essential.

The agricultural specialist must first obtain a clear idea of the phenomenon's impact on the sector before asking a civil engineer to estimate damages sustained by the sector's physical infrastructure. This latter assessment should include damage to, or destruction of, livestock-raising facilities, product and input storage installations, the silting up or destruction of irrigation and drainage systems, and so forth. Therefore, close cooperation between these two specialists is essential.

As we have already suggested, agriculture is usually most affected by floods, frosts and droughts; in some instances, tropical storms and hurricanes may also affect urban areas, inflicting relatively more damage on productive sectors or infrastructure outside of agriculture. Disasters caused by earthquakes might only affect the agricultural sector by destroying or damaging such infrastructure as silos, warehouses and irrigation and drainage systems. Mudslides might affect both agricultural and urban areas.

Considering the environmental toll of most disasters, the agricultural specialist must also work in close cooperation with the environmental specialist so that the latter may include all the relevant information in his/her assessment. Such coordination assumes increasing relevance because the widening degree of degradation of natural resources prevailing in Latin America and the Caribbean is magnifying the current and future effects of natural phenomena. Losses of agricultural land through erosion and mudslides, destruction of flood control levees, changes in the course of rivers and the effects on the flora and fauna are some such factors to be considered.



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¹ For purposes of this Handbook, the sector comprises the subsectors of agriculture, livestock, fisheries and commercial forestry development.

It is equally important to identify the differential impact of the disaster on women. The ultimate aim is to determine damage in monetary terms, and since impact varies by sex, the design characteristics of rehabilitation and reconstruction tasks generally must be fashioned accordingly. Once again, the agricultural specialist must work in close cooperation with the gender specialist for the purposes of the assessment, providing him or her with the relevant information.

Agricultural sector products are normally processed and sold by persons or companies other than rural producers, so the agricultural specialist must also cooperate with the trade and industry sector specialists.

The preceding paragraphs make obvious the need for agricultural specialists to maintain a broad vision and define intersectoral ramifications.

In addition, she or he must analyze the post-disaster situation in connection with the immediate availability of food and whether shortages may arise. Sometimes a disaster forces farmers and pickers to abandon fields and focus on dealing with the emergency and repairing or rebuilding their dwellings. Earthquakes may curtail access to food supplies by damaging silos and warehouses. Long-duration floods –such as those caused by El Niño in Ecuador²– may prevent a crop from being planted, while prolonged droughts may seriously compromise the production and future availability of food.

- 2 The agricultural specialist must ascertain the characteristics of the phenomenon causing the disaster, because only then will he/she be able to effectively plan his/her work. Consider the case of a hurricane whose intense winds can destroy plantations and crops; the accompanying rains may lead to flooding of farmland either directly or by causing rivers to overflow their banks. Some crops that are very resistant to wind may be vulnerable to long periods of flooding, as are African palm trees. Earthquake damage, in turn, is usually limited to relatively small areas, whereas droughts frequently extend over vast regions and may even affect several adjacent countries. In other extreme cases, the natural phenomenon can give rise to widespread although temporary climate modifications, producing multiple effects on different sectors, as in the Bolivia and Peru highlands during El Niño in 1982-1983.³ Therefore, the agriculture specialist must be well informed on the characteristics of the intensity and reach of the natural phenomenon causing the disaster, as well as its major effects and the areas affected.

² ECLAC, *Natural Disasters in Bolivia, Ecuador and Peru*, Santiago, Chile, 1983; and Jovel, Roberto, et al., Consultants' Report for the Corporación Andina de Fomento, San Salvador, 1999.

³ ECLAC, *Natural Disasters in Bolivia, Ecuador and Peru*, Santiago, Chile, 1983.

Effects may vary significantly depending on the timing of the disaster in relation to the agricultural calendar. A tropical storm or hurricane may occur just at the time when coffee plantations are in bloom and thereby destroy or very significantly diminish the year's harvest. The situation may be different for annual crops. If a flood or a late onset of rains occurs when sowing has just begun, a new crop can be achieved by planting faster - growing varieties; however, the loss can be total if the disaster strikes when the crop is ready for harvesting and it is no longer feasible to sow a new one in the same year. Much depends on the type of crop or plantation in question. In 1979, back-to-back hurricanes David and Federico struck coffee-growing areas in the Dominican Republic. In some instances, plants were uprooted and the loss was total, whereas damage was only partial in other areas.⁴ Permanent plantations generally sustain longer-lasting damage than annual crops because their recovery is slower. When part of a plantation is lost, it must be replanted, the related infrastructure –channels, drains, transportation networks, etc.– has to be rebuilt, and producers must wait several years for plants to mature and begin producing again. Such was the case of banana plantations located on the northern coast of Honduras hit by Hurricane Mitch in 1998.⁵

The agricultural specialist must also determine the destination of lost or affected production. In an area of subsistence agriculture, a disaster may have severe social repercussions. When an area is used for commercial crops, quantification of losses is essentially done in economic terms; the assessment must include an estimate of production losses, the evaluation of the national food balance and an estimation of import requirements to cover any shortfalls in foodstuffs.

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An additional effect is felt when the production lost is a raw material for the functioning of an industry, such as sugarcane, sisal or vegetables for canning. Sugar refineries, which generally have quite a broad area of influence, may find it unprofitable to bring cane over long distances or to use damaged roads given the higher transport costs they imply.

When export-oriented agricultural production is damaged, the impact is felt both on the level of the local economy and in the balance of trade and the current account, potentially upsetting macroeconomic equilibriums. Production losses that are compensated through imports may create similar imbalances.

Finally, any decrease in the agricultural sector's production, as in all productive sectors, causes losses of employment and income for agricultural workers. These must be estimated in close cooperation with the employment specialist, making use of known ratios between the volume of production and the required use of labor.

⁴ ECLAC, *Dominican Republic: Repercussions of Hurricanes David and Federico on the Economy and Social Conditions*, Mexico City, 1979.

⁵ ECLAC, *Central America: Analysis of the Damage Caused by Hurricane Mitch*, Mexico City, 1999.

2. Description of damages

When carrying out the assessment and preparing the respective report, the agricultural specialist must clearly describe the type of crop or plantation that has been affected, as well as its geographic extension. The description must be accompanied by the most accurate quantification possible of the areas and production affected. Bear in mind that damage may vary in nature depending on whether annual crops or permanent plantations are affected.

The damage to plantations and permanent crops may vary from total loss to only partial damage. Remember that a single natural phenomenon –such as a tropical storm or hurricane– can completely destroy plantations in its path and unleash torrential rains and winds that rob plants of their blossoms (such as coffee) or flood lands used for plantations sensitive to excess water (such as bananas).

- 4 Hurricane Fifi's impact on Honduras at the end of 1974 is a good case in point. The storm made a landfall in the northeastern part of the Honduran Atlantic coast, moved along a river valley that runs east-west, and damaged an area of excellent and highly productive land that was home to livestock and primarily banana, African palm, maize and rice. Banana plantations were located directly in the path of the hurricane and were practically destroyed. On the other side of the river, however, oil-palm plantations endured strong winds and more than two weeks of flooding. The rice and maize in the flooded area practically disappeared, while those planted in the upper sections of the river basin survived. Smaller animals –poultry, pigs and goats– practically disappeared, along with cattle that did not manage to take shelter on higher ground.⁶

The agricultural specialist must prepare a comprehensive description of the effects on the entire environment: natural resources, physical infrastructure, working capital, damaged or destroyed machinery, livestock and so forth. Such reports should include the full range of disaster reverberations for agricultural land, such as when excessive rains and flooding cause mudslides or the silting of productive lands located on hillsides and neighboring plains whose recovery may be unfeasible or either economically or environmentally non-cost-effective. A volcanic eruption's wind-blown ash may cause temporary damage by destroying crops, but in the medium and long - term may give rise to benefits by enhancing the yields of future crops.

The destruction of terraced fields and flood-induced deposits or waste may provoke losses, but it may eventually be possible to return such land to its pre-disaster state. A detailed description of these problems makes it possible to estimate future production shortfalls on such lands, as well as the stored products or inputs that were destroyed. A tropical storm's winds and flooding may cause a drastic, months-long decrease in milk and egg production as farm animals become stressed. Although the specialist might not be able to completely quantify these future indirect effects, they must be noted when deemed significant.

⁶ ECLAC, *Report on the Damage and Repercussions of Hurricane Fifi on the Honduran Economy*, Mexico City, 1974.

The description of inputs or crops stored in silos is relatively easy, because it suffices to prepare a list of each one and their volume or worth, classifying damage as total or partial. This is important because sometimes damage can make a product useless for one specific end, but it can still be used for other purposes. An example of this is maize for human consumption whose presentation or attractiveness might be reduced, but which can still be used as cattle feed.

Therefore, the agricultural and the environmental specialists must carefully examine permanent or temporary damage to natural resources. In some cases, torrential rains may sweep rich hillside soils to the plains, thereby improving the fertility of alluvial soils even if they had initially been damaged by flooding. In some cases, relatively high investments may be needed to replace lost topsoil.

After volcanic eruptions, the layer of ash deposited on the soils might be quite thin and permit full production recovery. Of course, if the layer of ash deposited is too thick, the recovery cost of renewing productive agriculture could be prohibitive.

It is equally important to determine the effects on the “backyard economy” activities carried out by women for subsistence purposes or as a source of occasional and supplementary income. The backyard economy refers to relatively minor activities (producing foods or raising small animals and obtaining their by-products) common in rural and marginal urban areas. Although it does not involve high investments, backyard production is very significant for the economy and for covering the food needs of many households. Losses in this regard are usually total and make it impossible or very difficult for these women to feed their families. When such losses occur throughout large regions, obtaining food becomes difficult and costly. The situation is even worse in women-led households.

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Therefore, it is very useful to identify the affected population by sex, based on prior statistical information or, when necessary, through fast sampling procedures. For example, identifying groups of affected peasant women assists in the design of programmes and projects to rebuild their backyard economy. Identifying groups of affected men is also very useful because it is they who tend to temporarily or permanently migrate to cities or even to other countries in search of jobs or income after a disaster, leaving the women in charge of plots or farms. Rehabilitation and reconstruction programmes must take these differential impacts on women into consideration.

Although impact assessments are needed fundamentally for planning medium - and long-term reconstruction, they may allow the agricultural specialist to uncover more immediate problems or possibilities that should be reported to the respective authorities.

3. Sources of information

There is very limited time available to conclude assessment work, since its results are urgently needed in order to guide reconstruction. However, the agricultural specialist and other sector specialists must collect any additional information that may allow a description of the different types of effects and damage.

The first rough assessment that officials in affected countries generally conduct when a disaster strikes provide analysts with an initial source of information that is often extremely useful when it comes to beginning the detailed assessment. These preliminary assessments define the hardest-hit areas, the geographical scope of the disaster and its effects, and potential economic repercussions. However, the time constraints implied by the urgency of such initial reports and a number of subjective factors generally mean that the initial assessments made by officials tend to be more qualitative than quantitative in nature and to overestimate effects. Therefore, the agricultural specialist must test the validity of such preliminary assessments in the field.

After dealing with the emergency stage and initially assessing the situation, governments usually undertake a more detailed study, frequently accompanied by field surveys. This information is very useful to the agricultural specialist because it is often compiled by local experts who themselves live in the affected areas and are very familiar with local crops, their yields, prices and other information needed to carry out a detailed impact assessment.

The agricultural specialist must also collect information on long-term statistical series on production and trends in the affected region; such data make it possible to estimate what production would have been had the disaster not occurred and thereby allow for comparisons between pre- and post-disaster scenarios.

- 6 During the mission, the agricultural specialist must try to get as much information as possible from different sources, even if they are apparently contradictory. This will allow him/her to verify them in due course and use the one that, in his/her opinion, best reflects the actual situation. To do this, visits to the affected region must be as wide-ranging as possible. Field visits are normally difficult to undertake because of damage to communication routes, and in such case air transport should be obtained if possible –preferably by helicopter, given the advantages of maneuverability and the ease with which visits can be made to any place of interest– so that the visit can be made in as little time as possible. If visiting the whole region affected is difficult due to a lack of facilities, the specialist must prioritize his field visits as a function of available facilities,⁷ the extent of physical damage (if there is a large number of victims and infrastructure has been destroyed) and economic importance (e.g., if coffee plantations whose production is equal to half the country's foreign currency earnings are destroyed). In any case, he/she will have to be selective and choose to visit the areas that are most representative and most economically and socially significant.

7 At the time of the assessment mission, helicopters may still be in use for emergency work.

The field visits will permit interviews with local officials and people affected by the disaster, whose firsthand experiences and information can contribute to an understanding of the magnitude of the disaster and its effects. The agriculture specialist must also try to contact experts at different levels and in different activities; for example, the agriculture ministry's representative may have an overall view, whereas the extension agent may have a very specific view of the area in which he/she works. Contact must also be established with service providers, vendors of agricultural inputs and so on. who may know the structure and size of local food and raw materials demands, as produced and required by the agricultural sector. All of the above will allow the agricultural specialist to put together his/her own view of events.

Preliminary work must also be done to define in advance what information should be obtained during local interviews in the field. If there are no estimates on damaged infrastructure at the central government level, the field visit will provide an excellent opportunity to obtain such information. If, on the other hand, there are estimates but they have not been verified, interviews will allow such verification. In other words, the specialist must have a clear idea of what he/she wants or needs, and how to get it.

As has already been said, no information should be rejected, and no opportunity to talk about the disaster should be overlooked. Therefore, the agricultural specialist must also hold interviews with the national officials who prepared the preliminary damage assessment or who are connected with agriculture in various ways, such as agents from the sectoral planning office. They must also consult directors of specialized institutions or trade associations that have some kind of influence or work in the area, such as those of coffee and banana growers, cattle farmers or crop dusting pilots. The same is true of international officials having some activities in the affected area. (FAO, IFAD, WFP, IADB, World Bank, OAS development projects, etc.).

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The specialist should also meet with representatives of companies involved in the transformation of agricultural products in the region, such as pasteurizers, packers, canners, fertilizer manufacturers and vendors. Their experts may provide information that will give the specialist a better idea of the impact that a lack of necessary raw materials will have on such companies, as well as additional ideas related to employment, recovery time, and so on.

Finally, in the immediate aftermath of the disaster, the printed press can provide knowledge that may assist in understanding the phenomenon, especially in the first stage, although care must be taken not to take at face value any quantitative information provided by unauthorized sources.

B. QUANTIFICATION OF DAMAGE

1. Direct damage

Direct damages to the agricultural sector refer to losses of capital assets. They may be grouped under four main headings: damage to farmland, whose recovery may take many years; damage to physical infrastructure (including irrigation and drainage systems, storage facilities, silos, etc.) and to machinery and equipment (tractors, spraying equipment, etc.); losses of crops that are ready to be harvested; and losses of stock (livestock, inputs, harvested products, etc.).

A distinction must be made here between the loss of crops ready for harvest, which is considered direct damage, and the loss of future harvests, which is regarded as indirect damage or losses, as we explain in detail later in this chapter.

a) Losses of farmland

The value of farmland lost, whether through erosion or total sedimentation, is difficult to estimate. Although the soil may have been lost and there is nothing that can be done about it, a value may be assigned to that damage on the basis of what the land would have produced over ten years based on the average productivity levels of the affected area. Thus, if a hectare of bananas produced an average net annual income of 20 000 dollars, a value of 200 000 dollars per hectare can be assigned to the loss.

A rough idea of the value of damage to the land temporarily affected by flood deposits can be developed on the basis of the cost of clearing a hectare of land that has minor tree cover. These figures are always available in ministries of agriculture or may be obtained from private companies that do such work. The agricultural specialist must estimate the affected surface area and estimate the total cost of recovering the land in question together with the civil engineering specialist.

8 It is more difficult to estimate damage to land that has been invaded by external agents that do not necessarily have a permanent effect on resources, such as land covered by volcanic ash. In the short term, the soil stops producing and there is no rule for projecting how long it will take for vegetation to recover. The volcanic eruption that occurred in a Central American country just as the cotton harvest was being picked is a good example. The immediate result was a lowering in the quality of the fiber collected, with a corresponding fall in price. However, because the layer of ash deposited was thin enough to be plowed into the soil, agricultural activity was reinitiated the following year. In some cases, the content or composition of the ash leads to an increase in soil productivity, so it must be analyzed before it is folded into the soil by machine. When the ash deposits are too thick, the rehabilitation costs and period are greater. Of course, future harvests that will not take place because of this phenomenon must be registered as indirect losses.

b) Damage to agricultural infrastructure and equipment

Damage to the sector's physical infrastructure (irrigation and drainage channels, storage facilities, silos, machinery, laboratories, corrals, chicken sheds, aquaculture pools, fishing port installations, etc.) and equipment is estimated on the basis of physical units affected, whether totally or partially destroyed. The agricultural specialist must estimate the extent of the damage, using physical units such as kilometers of farm roads, length of channels in meters and number of tractors, and then co-operate with the civil engineering specialist to determine monetary values. Table 1 shows the type of estimate that must be carried out in the case of direct damages to infrastructure, and Table 2 describes damage to assets at the farm level.

In this regard, differences between present and replacement values of assets referred to in Section One of this Handbook –on valuation criteria– must be taken into consideration.

c) Production losses

Strictly speaking, only production ready to be harvested at the time of the disaster can be taken into account under this heading, because only then can it be considered an asset.

However, if the disaster occurs while annual crops are still growing, it is necessary to register the loss on investment in labor and inputs. If a crop is totally destroyed, the costs incurred by producers must be estimated in accordance with the stage of the crop. If destruction or damage is partial, estimates must be prorated accordingly. The costs of the forthcoming harvest cannot be considered as damage since that would imply double accounting. If imports are used to replace lost crops that could not be replanted, the value of those imports must be indicated so the macroeconomics specialist can take it into account in the analysis of post-disaster economic performance. In no case must they be added as direct damage.

Table 1
DAMAGE TO INFRASTRUCTURE

Item	Description of damage	Cost, millions US\$
1. Access roads	70 km of dirt access roads in poor condition.	
	(2) 22-m long Bailey bridges, destroyed.	
2. Infrastructure	6 km main channel, water intakes 14 to 27, destroyed	
	20 postes eléctricos 1 transformador, etc.	
	7 water intakes and equipment	
	800 m of power line to operate pumps	
	20 electricity posts 1 transformer, etc.	

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Estimating damage to permanent plantations is more difficult. It requires an estimation of costs incurred throughout the planting and maturing period (several years in all cases) before they production is resumed. In some cases it will also be necessary to repair or replace production infrastructure, such as networks of cables to transport bananas to the packing plants or irrigation and drainage channels. These costs must be estimated under the previous heading, using information that can be provided by the affected companies.

In the case of livestock, no losses or direct damage should be registered under the heading of production. Instead, they are considered losses of stock (which are examined under the following heading) or of future production (which is taken into account as indirect damage). As noted earlier, the volume of losses of each crop or plantation must be estimated first so that they may then be expressed in monetary terms, based on prices paid to the producer.

Table 2

DAMAGE TO CAPITAL ASSETS AT THE FARM LEVEL

Item	Description of damage	Cost
1. Land affected	35 hectares silted with sand, totally lost 150 hectares flooded with waste material, but recoverable	
2. Irrigation and drainage system	100 km of main channels 750 km of secondary channels 210 km of silted drains	
3. Machinery and equipment destroyed	10 tractors 2 seeders 3 pumps 5 tow-trucks 1 truck 7 spray pumps Sundry equipment	
4. Crops and inputs lost	21 tons of maize 5 tons of maize seed 50 bags of fertilizer 1,500 liters of gasoline 17,000 hessian bags	
5. Other production goods	16 mules 70 bales of hay, etc.	
	1 granary, 700 m ² concrete and brick construction	
6. Buildings and installations	2 granaries, 950 m ² adobe construction	
	1 milking parlor, adobe	

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d) Losses of stock

Stocks of inputs and agricultural production that has already been harvested and stored may be totally or partially lost. In the case of total loss, damage must be estimated at farm prices and inputs at replacement value. Estimates of partial loss or damage are made on a prorated basis.

In the case of livestock, when estimating the value of losses, a distinction must be made between beef, dairy and breeding cattle, because prices and unit values are different. Production losses under this heading are estimated as indirect damage.

Previously harvested and stored pasture that may be lost as a result of the disaster must be included in the estimation of stock, based on a value determined in cooperation with experts and farmers in the affected areas.

In regions devoted to peasant agriculture, cattle raising usually provides only a supplement to the population's total income. Losses of larger animals, especially those used for agricultural work, must be taken into account at their market prices.

Losses of stock are included in Table 2.

2. Indirect losses

For this sector, indirect losses refers to any decrease in production throughout the recovery period resulting from direct damages caused by the disaster. Indirect damage also includes the cost of works required to prevent or mitigate damage by similar phenomena that may occur in the future.

Indirect damage to annual or seasonal crops occurs when there is not enough time to re-sow for a second harvest or when an extended flood or the absence of rain prevents the planting of one or more crops or reduces crop yields. In such cases, we recommend that future losses be estimated on the basis of their probable physical volume, taking into consideration the average productivity levels for the affected areas, broken down by each affected crop. In the case of plantations or permanent crops, productivity is reduced by damage to the plants themselves. Examples include coffee and fruit trees, whose future productivity may decrease due to the loss of blossoms.

Livestock production also decreases because of emotional stress on animals affected by natural phenomena. For example, after a hurricane or prolonged flood, hens stop laying eggs, and cows lose a lot of weight and their milk production falls. These indirect effects are difficult to estimate. They are frequently calculated as decreases of up to 20% of normal production, but one should consult local experts and affected producers who have faced similar experiences in the past, before deciding on the percentage to be applied. The disaster can also have a significant impact on the growth of pasture. Some pasture may be completely destroyed by floods –as in the case of Jaragua, Estrella or Taiwan types– or by drought. In such cases, the indirect damage caused by the disaster can be estimated as the cost of replanting pasturelands.

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Fishing or the future production in aquaculture systems can be affected in various ways. Floods or high tides may destroy shrimp - growing reservoirs or pools used in some countries, diminishing production during the rehabilitation period. Fish capture may fall when seawater temperature and salinity change, as in the case of the El Niño phenomenon along the Pacific shores of some South American countries, or when major earthquakes occur whose epicenter is located at sea. In the recent case of El Salvador, shoals withdrew to deep sea locations that could not be reached by artisan fishing boats.⁸

Note, however, that hydro-meteorological phenomena may also have positive effects on production. The El Niño phenomenon has opened up normally arid or semi-arid lands for the temporary production of highly profitable crops, and has given fisherman access to high-value fish species that normally inhabit other latitudes. These increases in production must be subtracted from losses of traditional products to obtain a net damage result.

⁸ ECLAC, *The January 13, 2001, earthquake in El Salvador*, Mexico City, 2001.

The construction of defense or mitigation works against future natural phenomena is essential. In one Central American country, significant and extensive flooding occurred on coastal plains after heavy rains exceeded the capacity of watercourses to quickly discharge runoff into the sea. Moreover, the sediments brought down by the floods were deposited in river deltas, further reducing the capacity to discharge runoff. The delta had to be dredged, and protection levees were built along major sections of the rivers. The cost of such work was registered as indirect damage caused by the disaster. Other types of indirect damages might include reforestation on the upper reaches of river basins and the training of riverbeds along certain sections.

Table 3 below is an example of how to calculate indirect production losses.

3. Total damages and losses

Total damages caused by a disaster can be obtained as the sum of direct damage and indirect losses. As an example, Table 4 describes agricultural sector losses caused by hurricane Mitch in Honduras in 1999, with a detailed explanation given in Appendix X. Total damage estimates must also be broken down between that sustained by the private and public sectors, because reconstruction might be dealt with differently in each case. Steps must also be taken to determine the geographic or spatial distribution of damage in order to provide criteria for prioritizing reconstruction programmes.

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Table 3

ASSESSMENT OF PHYSICAL AND ECONOMIC DAMAGE IN AGRICULTURE, BY AREA AND SECTOR

Region of the country	Area planted before the hurricane, hectares	Total affected area, hectares	Area with total damage, hectares	Area with partial damage, hectares	Amount of losses at the farm level, thousands of dollars ⁹	Percentage of total damage, %
Central	61,451	48,075	30,067	10,003	143,706	55.9
Southwest	56,621	17,826	9,355	6,471	13,994	5.4
South	46,317	12,253	5,232	7,021	15,010	6.2
East	34,169	21,325	6,926	14,399	10,334	4.2
North	117,393	37,301	14,303	22,998	43,392	16.9
Northeast	30,657	11,007	4,794	6,293	3,422	10.3
Northwest	128,984	54,292	13,600	40,692	26,360	1.3
National total	475,502	202,239	84,357	117,002	257,127	100.0

Source: Department of Agriculture.

⁹ Includes the cost of replacement of capital – which in the case of permanent crops will be spread over several years – but does not include losses of stock or losses due to the effect of paralysed production. That is why these figures do not necessarily coincide with those in Table 4.

Total damage and losses should not include the cost of any imports to replace lost production for internal consumption, or exports that do not take place due to lost production, as this would imply double accounting. Those figures, however, should be taken into consideration by the macroeconomics specialist in the external-sector analysis. The same applies to any loss of individual or family income due to production shortfalls, which should be added to the corresponding figures for other sectors describing the effect of the disaster on employment and income at the national level.

Table 4 below offers an example of the total cost of direct damage and indirect losses, as well as their impact on the external sector in terms of lower exports and greater imports.

Table 4

HONDURAS: LOSSES IN AGRICULTURE, LIVESTOCK, FORESTRY AND FISHERIES
ARISING FROM THE EFFECTS OF HURRICANE MITCH IN 1998
(Millions of lempiras)

Sector and subsector	Total damage	Direct damage	Indirect losses	Impact on the external sector	
				Increase in imports	Decrease in exports
Total	27,424.5	16,554.2	10,870.3	561.2	5,864.2
Agriculture (1+2)	23,256.3	14,105.3	9,151.1	561.2	5,492.9
1. Assets (A)	11,535.2	11,535.2			
Soil	5,214.4	5,214.4			
Plantations, facilities	6,320.8	6,320.8			
2. Production: Crops	11,721.2	2,570.1	9,151.1		
Domestic consumption (B)	901.5	772.8	128.4		
Rice	128.4	30.9	30.9	19.3	
Beans	156.5	66.8	89.7	104.2	
Maize	611.6	609.1	2.5	383.5	
Sorghum	97.0	66.1	30.9	54.3	
Exports and Industry (C)	10,819.7	1,797.3	9,022.4		
Bananas	6,548.9	466.5	6,082.4		4,276.8
Coffee	854.9	629.2	225.7		600.3
Sugarcane	747.2	387.0	360.2		85.5
Citrus	440.2	30.0	410.2		25.0
Melon	473.6	31.7	441.9		530.2
African palm	862.9	143.8	719.1		
Pineapple	177.0	11.0	166.0	...	
Other	715.0	98.0	617.0		
Livestock (1+2) (D)	3,492.5	1,886.0	1,606.5		0.0
1. Assets	2,755.4	1,763.1	992.3		
Cattle	1,217.3	225.0	992.3		
Poultry	738.1	738.1			
Physical facilities	500.0	500.0			
Pasture	300.0	300.0			
2. Production	737.1	122.9	614.3		
Milk	737.1	122.9	614.3		
Forestry (E)	46.0	27.0	19.0		
Fisheries (1+2)	629.7	536.0	93.7		371.3
1. Assets	119.0	119.0			
Fishing	14.4	14.4			
Reservoirs	104.6	104.6			
2. Production	510.7	417.0	93.7		
Fishing (F)	139.4	120.0			
Shrimp in reservoirs	371.3	297.0	74.3		371.3

Source: ECLAC estimates, based on information from official sources and productive sectors.

C. OTHER ASPECTS

The agricultural specialist must take into account several additional items when assessing the impact of a disaster on his/her sector to determine the impact on other links in the production chain –trade and industry– as well as the macroeconomic impact of the disaster. These include the effects on employment and income mentioned earlier; the impact of production losses on the food and exports national balance, which has effects on the external sector; the prices of agricultural products at different points or levels in the production, transformation and commercialization chains; the differential impact of the disaster on women; and effects on the environment.

1. Employment and income

Losses of employment and income after disasters are another trans-sectoral issue because they occur in most, if not all, affected sectors. The relationship between the production of different goods and the labor required to produce them is normally used to estimate said losses; these figures are generally available from labor ministries.

How to arrive at the estimate in all the affected sectors is described in detail in the chapter on employment and income in Volume Four; what is described here is solely related to the agricultural sector. In any case, the agricultural specialist must cooperate very closely with the employment specialist to conduct these estimates.

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After a disaster occurs, employment is affected for various reasons. When disasters destroy crops, field workers' income is compromised. We include under this heading losses to crops yet to be harvested, damages to major plantations, decreases in production due to floods or hurricane winds, destruction of or damage to farm roads that prevent the extraction of harvests and the like. In all these cases, the demand for labor decreases, so field workers' income drops. These costs are to be taken into account at the macroeconomic level after the corresponding totals with other sectors have been indirectly inferred.

The average amount of labor used on each crop under normal conditions serves as the basis for calculations. For example, 120 days of labor are required for the complete production of a hectare of coffee, including the harvest. If this production does not take place, around 80 workers will lose their income. The averages used in the estimates should be those for the affected area or country.

Milk and egg production will decrease, as will fish catches. In both cases the use of labor will be affected, and the workforce's income will be reduced accordingly.

An earthquake that produces widespread damage to agricultural workers' homes may impede such workers from attending to their normal duties in the fields because they have to deal with the emergency and the immediate rehabilitation of their houses, again with a corresponding drop in income.

This loss of employment and income in the agricultural sector, as in other sectors, must be broken down by sex so that the gender specialist can estimate the differential impact of the disaster on women.

Information on the loss of employment and income makes it possible to ascertain the decrease in the population's well-being and provides inputs for the design of rehabilitation and reconstruction strategies, programmes and projects employing otherwise idle labor.

2. Food and export balances

These items are included here because they have macroeconomic effects that must be quantified. A decrease in the sector's production may affect products intended for export and lead to a lack of sufficient food to meet the population's needs.

An assessment of the national food balance is essential for identifying total food requirements during the production rehabilitation period whenever the disaster has compromised domestic capacity to fulfill the food needs of the population over a relatively long period. This assessment can be of enormous value, especially in small economies, because it identifies the future need for food imports along with the subsequent macroeconomic effect on the balance of trade and payments.

Information must be collected on the availability of food before the disaster, as well as on the food assistance that is expected to arrive from countries or institutions after the disaster has occurred. In other words, the total volume of available food must be determined, regardless of its source. Later, an estimate of total demand is prepared based on the number of affected people, the estimated per capita consumption of each type of food and the expected duration of a domestic shortfall in the production of each foodstuff. The deficit for each of the food items affected by the disaster can be calculated as the difference between expected supply and demand.

The following table shows how analysts estimated the food balance in Honduras following hurricane Mitch in late 1999.

Table 5
FOOD BALANCE IN HONDURAS AFTER HURRICANE MITCH

Product	Per capita consumption, kgs	Total consumption, tons ¹⁰	Total production after the disaster, tons	Donations received from abroad, tons	Imports required, tons
Maiz	125	875,000	670,000	200,000 ¹⁰	5,000
Frijol	30	210,000	200,000	— ¹¹	10,000
Sorgo	—	—	—	— ¹²	—
Arroz	—	—	—	—	—
Trigo	—	—	—	— ¹³	—

10 Estimated based on a population of seven million inhabitants.

11 Donation received by means of Act PL480 of the United States of America.

12 Several donations from friendly countries.

13 Cash donation made by the government of the Federal Republic of Germany for the purchase of rice.

14 Donation made by the World Food Program (WFP).

To anticipate possible decreases in exports resulting from disaster-induced production losses, the specialist must examine statistics for recent years and as forecasts for the year of the disaster. Once the volumes that can be effectively produced after the disaster are ascertained and compared with projected exports, it is possible to determine the volumes that will not be sent abroad as a result of the event. That procedure must be followed for each of the export products while estimating lost volumes in tons. The macroeconomics specialist will be responsible for determining the impact of those lost exports on the country's external sector.

3. Sectoral output

The agricultural specialist must develop a table describing the production for each product under both normal and post-disaster conditions as his/her contribution to the analysis of the effect on macroeconomic variables. All products, or at least those accounting for 85% of the sector's gross output, must be included in the analysis.

The table must include information on production volumes and on prices at the various stages of production, transformation and commercialization, as indicated above. This will allow the macroeconomics specialist to estimate the effect of production losses in the sector on national GDP, and it will provide a basis for the trade and industry specialists to undertake their respective loss estimates.

A description of the type of prices that the agricultural specialist must obtain for his/her assessment is included below.

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a) Producer prices

The estimation of production losses must be based on the prices paid to the producer for each item. These unit prices can be obtained in countries' statistics offices or in the agricultural economics offices of the respective ministries, especially when a government agency guarantees the prices of certain products to farmers. International prices for a product should only be used in the case of items that are exported abroad.

b) Wholesale prices

These are prices at which industries generally sell already processed products to wholesalers. Comparing them to the prices paid to producers can provide a first estimate of the costs of transforming or processing agricultural products. Information on these costs is also usually available in national statistics offices or ministries of trade or economy.

c) Retail prices

These are the final prices paid by consumers for products acquired at shops. The difference between retail prices and wholesale prices provides a measure of the cost of commercialization. Once again, this information may be found in statistics offices and in ministries of economy and trade.

d) Government guaranteed prices

Governments sometimes guarantee prices to producers, primarily for articles deemed to be of strategic interest to the national economy. Guaranteed prices ensure farmers a minimum income at harvests. National sectoral offices and ministries of trade and economy can provide relevant information.

e) Import prices

Imports may be needed to make up for food shortages resulting from actual or foreseen production losses caused by a disaster. To estimate the value of such imports, use the food balance to ascertain the required volume, and then determine import prices—including insurance, freight and corresponding commercialization margins—with the help of representatives of commercial enterprises responsible for the imports.

Table 6 shows typical prices of certain agricultural inputs for one of the countries in the region, which might be useful for the agricultural specialist.

Table 6
PRICES OF SELECTED AGRICULTURAL INPUTS

Item and characteristics	Price in dollars a/
Tractors	21 000
Ford 6600 77 HP	26 500
Ford 6610 84 HP (Imported)	
Ford 6610 103 HP (Imported)	
TW-25 164 HP	
Certified seed (per ton) b/	
Maize	860
Beans	710
Forage sorghum	280
Grain sorghum	415
Rice	190
Soy bean	410
Wheat	325
Fertilizers (per ton)	
Urea (loose)	88
(in bags)	102
Ammonium nitrate (loose)	70
(in bags)	81
Ammonium phosphate (loose)	197
(in bags)	224
Ammonium sulphate (loose)	46
(in bags)	56
Phosphoric acid (loose)	166
Anhydrous ammonia (loose)	91
Triple phosphate (loose)	109
(in bags)	123
Simple superphosphate (loose)	46
(in bags)	54
Potassium chloride (loose)	110
(in bags)	125
Potassium sulphate (loose)	199
(in bags)	213
Potassium nitrate (loose)	241
(in bags)	254

a/ At market prices in Mexico, 9.50 pesos per dollar.

b/ Price of certified seed in the 2000 spring - summer cycle.

f) Export prices

As indicated above, the value of lost production must be expressed in terms of prices paid to producers, while that of export products should be determined by applying international prices for the lost or unproduced items. These prices are normally available in FAO Yearbooks and other publications of international organizations related to trade in agricultural products, as well as in local ministries of agriculture and foreign trade.

4. The differential impact on women

Section Five contains a thorough description of the uneven effects of disasters on men and women and how to estimate this differential impact. This is done because specific programmes and projects can, and must, be designed for implementation by women as part of rehabilitation and reconstruction programmes. The methodology required to carry out this assessment is set out in the aforementioned section, along with the requirement that each sectoral specialist work in close cooperation with the gender specialist. It is difficult to make estimates in this regard because the backyard economy is not yet included in national accounts, which is the basis for the assessments presented in this Handbook. This oversight notwithstanding, it is possible to estimate losses in this all-important productive heading.

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In other productive sectors, women operate micro and small enterprises from their homes to supplement family food and income. The corresponding activities in the agricultural sector are known as the backyard economy. The agricultural specialist must carry out special estimates of losses of stock and production associated with such activities, which tend to be more heavily affected in the rural sector.

Losses of chickens, pigs and other small animals represent losses of stock in the backyard economy. Their quantification is difficult and is usually estimated indirectly for each affected area as a percentage of the family's total assets (housing, household goods and furniture). Values ranging between 10% and 40% of those assets are used, depending on whether the family belongs to subsistence or more developed agriculture. The agricultural specialist must make this estimate based on on-site interviews or on data obtained through quick surveys or samplings. The methodology must be developed in close cooperation with the gender specialist to ensure that there are no omissions or duplications. Asset losses in the backyard economy are over and above asset losses estimated for the agricultural sector.

Any decrease in backyard-economy production also represents indirect damage that must be estimated. In the absence of detailed and reliable information on this heading, the agricultural specialist –in close cooperation with the gender specialist– must estimate this loss as a percentage of household income, taking into consideration the direct loss of stock in this same heading. In other words, indirect damage may be estimated at between 20% and 40% of the household's formal income, depending on the corresponding income level. Field visits must be made in order to directly interview the men and women affected, and surveys or samplings must be made to decide on the value to be adopted. As in the case of asset losses, these production losses are over and above those estimated by the agricultural specialist for his/her sector.

Women's employment and income in agricultural activities is another area usually affected by a disaster. The impact can be estimated based on cooperation and interaction among the agricultural, gender and labor specialists. An example of such analysis is included in the appropriate chapter in Volume Four of this Handbook.

The resulting estimates of the effects on women's assets and contribution to the backyard economy –as well as figures for damages to the environment– must not be added to the total losses for the sector because their components are not as yet included in the national accounts. Total damage figures are used to analyze the effect on macroeconomic variables, which are estimated based precisely on the use of national accounts.

Below is a list of information that the agricultural specialist must obtain, with close cooperation and support from the gender specialist, to estimate losses caused by the disaster in the agricultural sector.

In connection with direct damages, the following data or information must be estimated or determined by means of quick surveys or sampling:

- Losses of productive lands, by sex;
- Losses of subsistence agricultural production already harvested or about to be harvested, by sex;
- Losses of export agricultural production already harvested or about to be harvested, by sex;
- Losses of assets in agricultural cooperatives, by sex;
- Losses of major or minor animal stocks, by sex and producer level; and
- Losses of fishing assets (vessels, engines, nets and tackle) by sex.

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In regard to indirect losses, the following information must be obtained, either through estimates or field samplings:

- Future losses of agricultural production, by sex;
- Future losses of livestock production, by sex;
- Losses of livestock production in cooperatives, by sex;
- Future losses of fish catches, by sex; and
- Losses of employment and income by women wage earners in the sector.

5. Impact on the environment

The methodology for assessing damages caused by disasters to environmental assets and flows of environmental goods and services is presented in the respective chapter in Volume Four of this Handbook. Agriculture, livestock and fishery are sectors based on the country's natural resource endowment. Production factors such as physical infrastructure, labor and business management, and technology are incorporated in the natural capital for obtaining environmental goods such as agricultural, forest and fish products. Agriculture and fishery sectors, in turn, are related to environmental services provided by specific ecosystems. Used in a sustainable way, forests, in addition to timber and non-timber forest products, provide environmental services such as carbon sequestration, biodiversity conservation and water flow regulation.

The same happens with agro-forestry systems such as shadow coffee production. Genetic diversity is one of the most important assets for agriculture; some production systems, mainly traditional ones, contribute to biodiversity conservation. Similarly, the productivity of fisheries in some regions is related to the health of ecosystems such as mangrove forests, coral reefs and sea-grass beds.

Therefore, a close relationship exists between damage assessment in the agriculture and fishery sectors and environmental damage assessment. In terms of quantification and valuation of damage, two situations should be distinguished (for details, please refer to the chapter on the environment):

a) Environmental damages included in the assessment of the agriculture sector

These are direct and indirect damages (loss of natural capital and changes in the flows of environmental goods and services) that are already accounted for in the agricultural sector. Examples include losses of agricultural land and timber forests, as well as decreases in agricultural and fishery production during the recovery period after the disaster. The environmental assessment seeks to identify the share of these damages that refer to the contribution of natural capital, isolated from contributions of human capital and other assets such as infrastructure, machinery and equipment. This contribution is estimated using the economic rent concept (the difference between market prices and production/extraction costs). To avoid double accounting, these estimations should not be included in the damage overview.

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b) Separate quantification and valuation

This refers mainly to the valuation of assets and environmental services related to productive activities that are not accounted for in the agricultural sector assessment. Examples include changes in environmental services such as carbon sequestration, water flow regulation and fishery habitat that result from losses of forests, mangroves and agro-forestry systems. These damages should be included in the damage overview as they have not been considered in the agriculture damage assessment.

APPENDIX X

AGRICULTURAL LOSSES IN HONDURAS FOLLOWING HURRICANE MITCH

The following concepts were applied to estimate agricultural losses:

- A) **Loss of assets.** One of the most significant effects of the hurricane, in terms of both its short - and long-term repercussions, was the loss of assets, including physical facilities, investment in plantations and the production capacity of soils that lost their top layer. Floodwaters ruined agricultural land, covering it with a diverse range of materials.

Pending a detailed survey, it was estimated that soil loss was total on approximately 10 000 hectares, located mainly on floodplains. Stone deposits were the predominant factor in these areas. In one area of roughly 750 hectares, it was decided that the high cost of eliminating sand sediment might be justified by crop profitability. However, before land covered by sand and materials can be used productively, considerable expense must be incurred in cleaning and leveling works.

Mud deposits can be beneficial because they improve soil quality, but several agricultural seasons must pass before the site can be used. Soil losses due to mudslides were detected on approximately 7 000 hectares of mountain slopes used for growing coffee; recovery will take many years.

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Estimated total soil losses amounted to 5 200 million lempiras in lost net income (see Table 4). Losses in plantations and ancillary facilities amounted to 6 300 million lempiras. As a whole, they accounted for 50% of the total damage in the agricultural sector. In the case of some crops and regions, new seeds would be needed for planting.

Since agriculture in the valleys was significantly damaged, proper management of hillside agriculture became more important, not only as a source of supply and income for a sizable sector of the rural population, but also as an integral part of sustainable development for the forestry and agriculture sector.

- B) **Crops for domestic consumption.** The hurricane coincided with the end of the harvest of certain crops and the planting of others, so availability of those products would drop the following year. The deficit would be smaller if soil humidity conditions allowed for a second crop. The magnitude of production losses is shown in Table 4.

In the case of maize, data shows that approximately one - third of the first (and most important) harvest for the 1998-1999 farming year had already been collected, whereas in the area still to be harvested production would be reduced by 250 000 tons, worth 609 million lempiras (see Table A below). Excess water generated by the hurricane resulted in extraordinary costs by preventing the use of machinery for the harvest, which had to be done manually. That value is recorded as indirect damage. At the same time, the poor state of roads hindered transportation of the crop to collection and grain-drying centers, thereby undercutting quality.

The first harvest in the bean cycle had also been collected at the time of the disaster and the second crop, which provides 75% of national production, had already been sown. In the area planted, losses were estimated at 30%, which entails approximately 9,000 fewer tons of beans than were available in 1999. This shortfall would have to be compensated through additional imports. Replanting was possible, but not over the entire affected area. The direct damage of 67 million lempiras includes lost production in the first harvest, as well as investment in the planting of the damaged areas. Indirect damage represents the harvest that was not collected.

Table A

HONDURAS: ESTIMATE OF PRODUCTION LOSSES IN MAIN AGRICULTURAL CROPS
AS A RESULT OF HURRICANE MITCH
(Thousands of tons)

Source:

Product	Production forecast before the hurricane	Production estimated after the hurricane	Lost production	Loss over expected production (%)
Basic grains				
Uncleaned rice	64.8	56.1	8.8	14
Beans	95.1	89.9	5.2	6
Maize	607.1	252.2	354.9	58
Sorghum	94.2	71.8	22.4	24
Industrial and export crops				
Bananas	872	766 a/	739 b/	85
Sugarcane	3,397	1,360	2,037	60
Coffee	153	126	27	18
Melon	203	144	59	29
African palm	576	415	161	28

ECLAC estimates, based on information from official sources and productive sectors.

a/ In 1998.

b/ The last months of 1998 and the 1999 harvest.

A similar situation occurred in the case of rice, as adverse weather led to a production shortfall of 8 800 tons. Moreover, excess water hindered growth on around 700 hectares already planted that were to be harvested the following year. Direct damage of 30 million lempiras reflects lost production and investment. Indirect losses of 5.5 million lempiras represent future production that will not be obtained.

The volume of sorghum lost was greater than that of rice and beans, since barely a tenth of the harvest had been collected and almost a quarter of annual production was lost. Because a part of the planted area ready for the next cycle was damaged, supply was expected likely to fall by an estimated 10 000 tons.

Expectations of a considerable drop in the supply of basic grains led to uncertainty and a scarcity in markets that was aggravated by difficulties in the transportation of goods as a result of the deterioration of highways and access roads in production areas. To prevent price increases, the government reached an agreement with producers and wholesalers for a temporary price freeze. To meet the demands of industry and direct consumption, officials considered a zero tariff on the import of certain basic grains that are sold within a price range and with a variable tariff of approximately 35%. However, once communications were stabilized to some degree, it became obvious that available short-term stocks were sufficient and that imports (a total of 560 million lempiras) could be deferred until the following year.

Support programmes would have to be designed in line with producers' socioeconomic conditions to mitigate the harm they sustained. The priorities of a rehabilitation and reconstruction program for the whole sector should include the rehabilitation of damaged agricultural areas, the recovery and distribution of genetic material, plant and animal health surveillance, access to financial resources through preferential credits to facilitate reactivation and, more generally, the introduction of river basin management practices and infrastructure reconstruction.

Table B

HONDURAS: AREAS OF MAIN EXPORT CROPS
AFFECTED BY HURRICANE MITCH
(Hectares)

Export crops	Production area before the hurricane	Area affected by the hurricane	Percentages
Total	292,000	83,760	29
Bananas	22,000	16,000	73
Coffee	194,000	38,800	20
Sugarcane	44,300	22,000	50
African palm	32,000	8,960	28

Source: ECLAC estimates, based on information from official sources and productive.

C) **Industrial and export crops.** As in the rest of agriculture, industrial and export crops sustained major direct damages, which were estimated at approximately 1 800 million lempiras. Moreover, since most losses refer to permanent crops that would have to be replanted in many areas, losses not only affected production during the current cycle, but would continue throughout the time required for new plantations to reach maturity (between two and seven years, depending on the crop). Total losses thus amounted to 6 000 million lempiras, including damage to assets and indirect losses of production over several years.

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Significant losses were reported for bananas, since almost all plantations are located in two of the areas most severely affected by floods. Large producers lost all or part of their plantations, as did many independent producers, particularly cooperatives. The Tela Railroad Company (Chiquita Brands) reported that between 50% and 60% of its plantations were damaged, while Standard Fruit Company (which normally hires about 10,000 workers) lost 80%. Independent producers had very high losses on some 6 000 hectares, of which only a small fraction can now be harvested to meet domestic demand and the needs of farmhands and cooperative members.

Floods affected current and future crops as many plants were destroyed. Although new plants could begin producing in one year, the time required to clean up and level fields should be taken into consideration. That year's crop losses (466 million lempiras) correspond to the November-December harvests, whereas indirect damage refers to production lost until the plantations would recover in two years' time. Infrastructure and plantation losses, totaling 3 500 million lempiras on approximately 16 000 hectares, are listed under the heading of assets.

Losses in coffee —the country's main export— amounted to 500 000 quintals, while a further 105 000 quintals of reserves were ruined when warehouses were flooded. Another 7 000 hectares were affected by landslides, as were many access roads to plantations. Over 100 coffee-processing facilities were either swept away by swollen rivers or rendered useless by flooding, which also caused significant damage to access roads and many bridges. Crop production losses were estimated at 629 million lempiras, while future production will be decreased due to the number of lost coffee plants. That loss is recorded under the heading of soils. The decrease in the next harvest and exports during the present and future cycles must also be taken into account, as the normal development of plantations was curtailed.

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Sugar cane losses were high in areas rendered useless by flooding, silting, mud, sand and stones. Although sugar cane is relatively resistant to excess water, it is difficult or impossible to harvest, either mechanically or by hand, when it is covered by mud. Furthermore, the inevitable postponement of the harvest decreased sugar yield. If delays were prolonged, it would no longer be economically feasible to harvest the crop. Damage to some mills and industrial facilities (the machinery in one of them was covered by water and mud) made the delay even greater and the situation more critical. It was therefore estimated that 50 percent of the planted area had been lost and that the value of the crop that could not be harvested during the present cycle was 387 million lempiras. Extensive areas would have to be replanted to ensure the recovery of sugar cane plantations, which is why the investment lost in plantations was also taken into account. The following year the sugar cane harvest would also be lower, and foreign exchange earnings from sugar exports in the next two years would decrease by some 85 million lempiras.

African palm losses have affected the cooperatives established following the agrarian reform, as well as independent producers and large enterprises. The most recently planted area sustained significant damage, since two to three year-old plants, which are the most vulnerable, were partially covered by mud. This affected the heart of the plants, which died as a result; adult plantations were better able to withstand the effects of the hurricane. Nurseries and other plantation-related facilities were also significantly affected. Damages sustained by plantations provide the basis to estimate present year production losses (143 million lempiras). This situation will continue over the next few years until the damaged plantations recover.

In melon production, which is concentrated in the department of Choluteca, 12 000 hectares had been set aside for planting to take advantage of market demand in the winter months. When the hurricane struck, 3 600 hectares had just been sown or were being prepared for sowing, and 80 percent were lost; the direct damage led to the loss of 32 million lempiras in investment. In contrast, indirect losses refer to the area that was not sown, resulting in lower exports in 1998 and 1999. Action was rapidly taken to recover the market, but only 7 000 hectares were set aside due to the total loss of fertile soil on farms that were covered with large amounts of sand and stones deposited by the river. These farms are included in the loss of agricultural assets, as are the substantial investments that would have to be made to recover some of the affected areas. Infrastructure was also significantly damaged, with more than 50 refrigerated transport containers destroyed; this item, however, is included in the transport section.

Citrus crops on the Atlantic coast were also seriously affected. Fortunately, grapefruit exports to Europe had concluded on October 15, so direct damage affected mainly the oranges and grapefruit for the domestic market. Production in the coming cycles would be lower because of the damage sustained by fruit trees; indirect losses were therefore estimated at 400 million lempiras. The greatest losses in assets occurred in the region of the Aguan valley, where an estimated 1 750 hectares of grapefruit were covered by sand and debris and were completely lost, and approximately 7 000 hectares of young orange groves were waterlogged for several days and would have to be replanted.

- D) **Livestock.** The beef and dairy herd was reduced by approximately 50 000 head, valued at some 225 million lempiras. Information on livestock-raising areas was incomplete, owing to difficulties in gaining access to such areas. Although livestock raising is carried out in the highlands, losses occurred among cattle grazing in the lowlands. Adverse weather conditions resulted in animal weight decrease, causing an estimated loss of 900 million lempiras.

On the Atlantic coast, where dairy production is concentrated, the supply of raw materials to industry dropped during the first week as a result of flooding on farms and adverse transport conditions. The losses sustained on those days would cause lower milk production for several months. Direct damage was estimated at 120 million lempiras, while the subsequent impact of lower production was expected to result in higher indirect losses in view of the time required for recovery.

Damage to poultry production amounted to approximately 740 million lempiras from the loss of 60% of poultry stocks. The damage to dairy farm facilities and fences, calculated at 500 million lempiras, would have to be repaired. Flooded grasslands would eventually recover, but investments would be required to improve pasturelands. According to information provided by the unions, 70 000 hectares were affected at a loss of 300 million lempiras.

The public sector lost animal health control facilities and laboratories that produce and record genetic material. Under the prevailing conditions, the sector's response and international support in preventing diseases were very timely. Reconstruction would have to include recovery of the lost installed capacity.

- E) **Forestry.** Timber production is an important activity in Honduras, generating export earnings of 20 million dollars. Sawmills suffered no major damage from the hurricane, although some machines were affected by water. Damage to roads was more of a problem, since it hindered access to logging camps. Lumber, however, was available for reconstruction purposes.

One of the most significant losses in the sector was timber from trees blown down by the hurricane, amounting to 100 000 cubic meters of pine. The most seriously affected areas were in the Sierra de Agalta of the eastern and western parts of Olancho and in Yoro. Losses, based on the average price per cubic meter, amounted to 27 million lempiras. If the sales price offset the cost of extraction, which was hindered by road conditions and remote locations, part of the losses could be recovered. Collecting this timber would have other benefits, such as eliminating potential sources of fire in the dry season and forest pollution.

In Atlántida, 25 000 additional cubic meters of timber from latifoliated trees were reportedly lost, and forestry plantations throughout the country were also damaged.

- F) **Fisheries.** Fishing on the Atlantic coast and shrimp production in ponds in the Gulf of Fonseca are very profitable in Honduras. The hurricane affected these two zones, causing damage to both artisan and industrial fishing fleets. Owing to the type of shrimp-farm investments in the south, it would seem that the economic impact was more significant in that area. A total of 13,700 hectares were flooded in Choluteca and Valle, and during the first few days after the hurricane, estimates indicated an almost total destruction of infrastructure and the loss of at least two of the 2.5 annual shrimp harvests. Once the water level dropped, it became apparent that damage was considerable but clearly not as great as originally feared. Pond and packaging facilities, as well as investment in larvae for the restocking of ponds, sustained damages amounting to 100 million lempiras. In production, direct damage was estimated at 300 million lempiras—a harvest of 3,200 tons of shrimp—plus indirect costs from the partial loss of the first 1999 harvest.

Coastal fishing sustained losses of 140 million lempiras, although information on losses in the 365-vessel fish, lobster and conch fishing fleet could not be confirmed.

II. TRADE AND INDUSTRY

A. INTRODUCTION

1. General considerations

This chapter has four sections. The first describes conceptual aspects that are common to trade and industry and that must be taken into account when assessing damage due to natural phenomena. The next two sections refer to each of these productive sectors. The presentation includes an overview both of the characteristics of the natural phenomenon and of the magnitude of damage in the sector; a description of the methodology and information sources that must be used to quantify direct damage and estimate indirect effects or losses; an estimation of the impact of the phenomenon on macroeconomic indicators or the manner in which damage and losses affect the performance of the main economic variables of the affected country; and recommendations on the definition of priorities that the responsible authorities must establish to meet the needs arising in both sectors from disaster effects. Finally, the fourth section contains a methodological appendix with formats of basic tables that the sectoral specialist can use as a guide, to be filled out with the information obtained from different sources as mentioned throughout the text.

To illustrate the methodology proposed for the assessment of direct damages, indirect losses and the corresponding macroeconomic effects on a national economy, the text draws on information from field research and various sources used to assess the impact of the 1999 floods in Venezuela.¹

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For each of the sectors, references are made both to the sources of statistical information most often available in Latin America and the Caribbean, and to complementary information that should be obtained from official sources, chambers of trade and industry and field work.

2. Characteristics that are common to both sectors

When assessing damage caused by a natural phenomenon, specialists will find certain similar features that run through the trade and industry sectors. In both economic sectors, value - added is generated in establishments that are well defined by their physical extension and facilities into large, medium-sized, and small enterprise categories. The peculiarities of each of these sectors differentiate them from other areas of the economy in terms of specific disaster effects and the actions needed for both the rehabilitation and reconstruction of productive units and risk reduction.

¹ ECLAC, *The Socioeconomic Effects of the Floods and Landslides in Venezuela in 1999*, Mexico City, 2000.

In both trade and industry, large establishments contribute the lion's share of production and are normally more modern than medium-sized and small businesses. Therefore, they proportionally concentrate more of the capital stock in both sectors. They also generally have more solid installations and frequently have insurance covering the risks of damage caused by disasters.

According to Latin American and Caribbean censuses, there has been a structural trend towards a decrease in the relative importance of small establishments in terms of numbers and value - added; however, they still account for a large share of employment in both trade and industry, a fact that has even tended to increase in recent decades. This has been due mainly to the low absorption of labor by the most highly productive units –which constantly incorporate technological advances– and the subsequent increase in informal activities, especially in trade in large urban agglomerations.

These small establishments operate under precarious conditions, which undoubtedly make them more vulnerable to natural phenomena. Their recovery tends to be quick, however, since their functioning is more directly related to the subsistence of the persons engaged in each enterprise and because proportionally less physical capital is prone to destruction than in larger establishments.

28 Both trade and industry concentrate most of their activity in big cities (although trade –especially the small and informal kind– is less polarized and can be found in medium-sized and small cities as well as in remote tourism centers). Therefore, they are relatively less affected by disasters occurring primarily in the countryside (droughts, floods, etc.), with the exception of agribusiness and those branches of manufacturing that have broad production chains extending all the way to mining, fishing, forestry, food processing and so forth.

Nevertheless, hurricane winds that strike coastal areas can have a significant impact on commercial and manufacturing activities when they are located in major cities on the coast or very near to it and when secondary and tertiary activities linked to tourism are significant.

These features, which are common to trade and industry, have an obvious influence not only on the type and magnitude of the damage a natural phenomenon can cause, but also on the support they might need for rehabilitation and reconstruction and for disaster mitigation.

There are other characteristics worth noting. Because of the large financial capital they handle and the scale of their investments in machinery, equipment, buildings, warehouses and stock, large establishments often have insurance against such types of risks, and their asset losses can be proportionally lower than those of small and medium-sized industrial and commercial establishments. On the other hand, micro-enterprises –which in many cases operate in their owners' homes and basically use domestic inputs– may react more flexibly and quickly to the effects of a natural phenomenon in order to safeguard their stocks of inputs and partially completed or finished goods, which are the bulk of their assets. In addition, as mentioned earlier, the urgent need to recover their only source of income requires small businessmen and artisans to quickly get their premises and workshops operating again, undoing the damage on their own.

The above reasons explain why accumulated assessment experience in the region shows that medium-sized industrial and commercial establishments require proportionally greater recovery assistance than small or large ones.

Breakingdown the impact on these sectors by sex is equally important. Although the aim is to determine the monetary value of the damage, both the impact and the required rehabilitation and reconstruction tasks take on different characteristics depending on the sex of the affected owners. The trade and industry specialist must work in close cooperation with the gender specialist for assessment purposes.

Finally, it is necessary to estimate the employment and personal income losses registered because of direct damage and production decreases in the trade and industry sectors. Such a calculation should be made in cooperation with the employment specialist, making use of known ratios of labor required for specific production volumes.

B. MANUFACTURING SECTOR

1. General considerations

The assessment of damages caused by a natural disaster in the industrial sector can be undertaken following a procedure of successive approximations, as described below. The starting point is the collection of basic information that will provide the specialist with an overview of the sector in the disaster area. Next comes the most accurate calculation possible of the specific damages sustained. Finally, a precise diagnosis of the situation must be made. This process will enable one to set priorities for the recovery of productive activities by defining reconstruction projects and programmes. It is recommended that the steps described below be followed.

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a) Collection and sources of information

One of the sector specialist's first tasks is the collection of basic information. In this activity he/she must proceed selectively because of the limited time usually available for such work.

The main domestic sources of information that should be used include the following:

- The most recent industrial census;
- Information and time series on production available in statistics bureaus, central banks or sectoral planning offices;
- Periodic surveys carried out by trade and industry ministries or by central banks;
- Information in periodic bulletins published by industry associations;
- Economic and statistical information published or made available by industrial or manufacturers' groups, such as the chambers of the textile, clothing, food, electrical appliance and construction materials industries;

- Information prepared by other groups on micro and small enterprises or businesses, which are sometimes available from development banks, manufacturing workers' unions or social security institutions;
- Information available in patent and trademark offices; and
- Information available from industry promotion offices or in municipal records.

In addition to local and national sources, the trade and industry specialist should consult the information available in the Latin American Demography Center's Redatam, which should provide a very precise view of pre-disaster conditions. Such data are useful for making damage estimates, identifying those affected and defining the bases for reconstruction programmes and projects. The Redatam network brings together census or household survey information in a coherent and compatible way, and presents it broken down by state, province and even municipality. For example, Redatam provided analysts with remote access to a highly useful body of information on the state of Vargas in Venezuela (economically active and employed population, productive activities, number of establishments by size, etc.).

Likewise, Internet searches before and during the assessment may reveal information on special characteristics of the most important manufacturing enterprises, which that might not be available through other sources.

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The sector specialist should promptly trace all available sources in order to obtain as much quantitative information as possible on the sector both nationally and in the disaster area. This set of background information should then be complemented with the most important specific information obtained in the field. All of the above will be used for the assessment of direct damage, indirect losses and macroeconomic effects.

b) Description of the affected area and of general damages

Immediately after a disaster occurs, the national authorities responsible for the post-disaster emergency stage usually act very quickly and provide general information on the nature of the phenomenon, the affected area and the magnitude of damage. Sometimes they also carry out quick surveys that help the specialist obtain an overview of the number of industrial establishments damaged or completely destroyed.

Based on a knowledge of the characteristics of the affected geographical area and the availability of primary information either provided by local authorities or collected from other domestic sources, the sectoral specialist –taking into consideration information from the most recent industrial census available and information collected from the sources mentioned above– must ascertain the approximate number of establishments affected; the industries to which they belong; their size, grouped into small, medium, and large, in terms of personnel employed; the employment and value - added each one generates; and the degree of interdependence on the productive activities located within and outside the area. This information will help one perceive any domino effects that might arise owing to the destruction of a given subsector's productive structure.

The sector specialist must then use this information, complemented with periodic assessments usually carried out by ministries and planning offices, to arrive at a quantitative and qualitative estimate of the situation of industrial activity in the immediate aftermath of the disaster. This will be very important for the subsequent estimation of the effects on changes in given macroeconomic variables.

The sectoral specialist, either individually or in cooperation with national authorities, must also conduct an informal survey among owners or managers both of the main industrial establishments and of a representative sampling of small and medium-sized companies, so as to obtain a clearer idea of the magnitude and nature of damage, as well as of the sector's most urgent rehabilitation and reconstruction needs. The survey may include information on companies' production chains that is unlikely to be found in the sources mentioned earlier, as well as the source of inputs and the destination of intermediate or final goods processed by the affected companies.

2. Direct damages

As soon as the sector specialist has a general idea of the effects of the disaster on the manufacturing sector in the affected area, he/she must estimate the damage more accurately, beginning with the value of direct damages.

The assessment's final purpose is to define reconstruction programmes containing specific projects and profiles. To that end, the following three types of direct damage must be determined to the fullest possible extent :

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- The value of the assets lost by manufacturing establishments, in their pre-disaster condition (in other words, measured in terms of their depreciated value);
- The replacement cost of lost assets, with the same characteristics as their original design; and
- The cost of reconstruction, including vulnerability-reduction components. The concept of vulnerability refers to the probability that a set of manufacturing establishments exposed to a natural hazard will sustain damage, depending on how fragile their installations are. The magnitude of this damage is directly related to their degree of vulnerability.

The assets considered in this calculation should be grouped by the sector specialist under the headings of buildings and facilities; machinery and equipment; transportation equipment; furniture; stocks of goods under processing; finished goods; raw materials; and spare parts.

The sector specialist must make these estimates in close cooperation with government offices responsible for the sector, as well as with trade groups and producers' associations. The specialist should verify all available official estimates during his/her field visits.

To obtain updated replacement costs for valuing losses of assets, the specialist could adopt internationally valid unit costs, at unit import prices, as well as costs used in development projects that the country's development banks might have in their portfolios and that, whenever possible, are in similar industrial branches and on a similar scale.

When calculating direct damage, the sector specialist should distinguish among establishments of differing sizes. Large establishments are those that employ 200 workers or more; medium - sized establishment employ between 199 and 40 workers; and small establishments employ 39 or fewer workers. Large establishments usually have more accurate accounting records; in this case, estimates should be based to a greater degree on interviews with the executives of such establishments. In the case of small establishments, the weight of fixed assets among total assets is very small, which, together with the precarious nature of the accounting information these establishments have, requires that the specialist carry out rougher, less accurate estimates.

32 Special attention should be paid to those manufacturing enterprises involved in productive processes making goods for re-export, known as in-bond (maquila) enterprises. Some characteristics of such enterprises –such as the fact that they are normally subsidiaries of, or dependent on, international enterprises, that they are normally backed by insurance against damage, that they are labor intensive and that their assets are possibly prone to rapid depreciation– should be taken into consideration for the assessment of disaster-related damages. In any case, the sector specialist should collect as much information as possible on these companies (when affected), ideally obtaining it directly from their executives and defining their corresponding incentives with local authorities.

The main categories into which destroyed or affected assets should be grouped for the purposes of assessing direct damages are presented below.

a) Buildings and facilities

Losses under this heading are to be valued at their pre-disaster condition cost (that is, at their depreciated value); at replacement costs with the same characteristics as their original design; and at reconstruction costs including vulnerability-reduction components. This will entail determining the destroyed or damaged surface area, the age of the facility and the current value of a square meter of construction in industrial-type buildings. This last factor generally varies as a function of the enterprise's size, because large enterprises require facilities and constructions of higher quality and complexity than medium-sized and small enterprises because of the machinery and equipment they use and associated technologies.

In each case, a definition must be reached in cooperation with national authorities on the vulnerability-reduction components that should be introduced in the reconstruction process, which will likely increase their cost. Alternatively, such mitigation components might encompass works that are external to and independent of facilities, such as ditches, river protection works, retaining reservoirs and channels. In the first case, there are important elements to be considered in construction-design and land-use regulation. Reconstruction should only be carried out on the basis of a significant qualitative improvement over the previous situation as regards vulnerability to future phenomena.

b) Machinery and equipment

Under this heading, it is necessary to determine the corresponding replacement prices for assessing total or partial damage to machinery and equipment. The value of these items as they appear in industrial censuses refers to the value registered in enterprises' accounting records and does not take into consideration accumulated depreciation as a function of the number of years of useful life since acquisition. They also show acquisition prices, except in certain countries with high inflation where a periodic restatement of physical assets is advisable. Such limitations are especially significant in the case of machinery and equipment, where rapid technical change governs the replacement value.

As in the case of buildings and facilities, losses of machinery and equipment in large industrial enterprises must be estimated directly by their executives, in consultation with national authorities. These figures must then be examined and adjusted by the sector specialist to obtain the current value of destroyed equipment, using as a basis the unit values of recent imports.

When assessing direct damage sustained by medium-sized and small establishments, the varied nature of potentially affected industries and the inconsistencies typical of data obtained through direct surveys may require analysts to rely more on census parameters, which must be assessed and updated.

c) Furniture and vehicles

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Larger enterprises usually have a proportionally higher stock of these goods, both because their personnel work under better conditions and because they more frequently have such equipment as forklifts and a fleet of vehicles for the transportation of raw materials, intermediate products or finished goods. Intermediate and small enterprises usually outsource these services. For valuating widespread damages sustained under these headings, the analyst may need to obtain updated market values for furniture and vehicles similar to those destroyed or damaged.

If the disaster is deemed to have had a relatively minor impact on this type of fixed assets, indirect estimates should suffice. For example, investments in furniture and equipment are, to a certain extent, proportional to the value of buildings and facilities, although the validity of this relationship depends directly on the size of establishments. It is also necessary to make distinctions between specific industries; for example, the relative importance of vehicle fleets among total assets is greater in the soft drinks and cement industries.

d) Stocks or inventories

This heading includes finished goods produced by the company in question; goods being processed; raw materials; and other goods such as spare parts that are not directly related to production. This is one of the headings experiencing the most damage during a disaster because space limitations often mean that warehousing facilities are less protected than those that house machinery and equipment.

The specialist must consider that a portion of stocks might have been imported. Relevant information on large enterprises can be obtained from official sources and from the enterprises themselves. In the case of medium-sized and small enterprises, estimates can be based on the application of the ratio of stock to total fixed assets, which is normally slightly higher for medium-sized companies.

Total losses of fixed assets can be obtained by adding the four previous headings. The imported component of direct losses must be estimated by calculating the foreign currency that would be required to replace the fixed assets and destroyed or damaged stocks. Various sources can be used for this, such as the domestic and imported cost structure of investment projects that might be available from development banks, as well as macroeconomics statistics listing the imported content of gross investment. Finally, a breakdown of damage among private and public enterprises must be made, because different patterns may be followed in reconstruction.

3. Indirect losses or effects

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Damage sustained by industrial establishments located in a disaster area will obviously have a negative effect on production flows because of both the temporary suspension of activities –for as long as the rehabilitation lasts and until the pre-disaster production level is recovered– and relative shortages of inputs caused by the temporary interruption of communications and sales channels.

The increased costs involved in choosing and using alternative (longer) transportation routes must also be added to indirect losses. These and can be especially important for certain sectors where the transportation of goods is a major cost factor, as in the case of the sugar and cement industries.

Losses due to an interruption of exports must be taken into account for the same reason, along with taxes the government stops receiving as a result of the interruption in production and sales. To complete the picture of indirect effects, emergency expenditures made by enterprises must be ascertained, as well.

Local associations of industrial entrepreneurs often carry out surveys aimed at estimating losses due to the suspension of production, whose results must be verified by the specialist by means of interviews with businessmen in the disaster area. In the case of small establishments, and whenever necessary, the specialist can even make calculations of production losses based on worker productivity coefficients obtained from census information or industrial surveys.

Trade associations also have information regarding which enterprises have been affected and which are mainly involved in export activities. The sector specialist must also take into account seasonal factors when calculating this type of damage because the impact on production flows rarely lasts for more than a year, judging by past experience in Latin America and the Caribbean.

For example, estimates of direct damage and indirect losses caused by the floods and mudslides that occurred in the Venezuelan states of Vargas and Miranda in 1999 were based on information provided by EDEINDUSTRIA for small and medium-sized activities and by CONINDUSTRIA for larger ones (Tables 7 and 8).

Table 7

DIRECT AND INDIRECT DAMAGE AND LOSSES SUSTAINED BY THE
MANUFACTURING AND NON - RETAIL ENTERPRISES IN THE
STATE VARGAS, VENEZUELA
(Millions of bolivars)

Type of establishment (units)	Direct damage	Indirect losses	Total damage
Drugstores (57)	1,130	830	1,420
Medical equipment factories	300	300	600
Pasta factories	125	125	250
Ironworks (315)	2,700	1,880	4,580
Bakeries (40)	1,600	1,600	3,200
Clothing workshops (337)	405	400	805
Footwear workshops	625	625	1,250
Mechanical workshops (17)	595	600	1,195
Radio stations and concessionaires (2 and 25, respectively)	395	350	745
Others	725	690	1,415
TOTAL	8,600	7,400	16,000

Source: ECLAC, based on official sources and those available from chambers of commerce.

The volume of non-commercial industrial activities in Vargas, the state most affected by the phenomenon, is rather small, consisting of a less than 800 enterprises. These are small establishments such as ironworks, garment and footwear factories and mechanical workshops. The vast majority of these establishments sustained total losses.

The state of Miranda, on the other hand, incurred significant losses because of the presence of the Guarenas/Guatire industrial complex – which includes such manufactures as plastics, batteries, laboratories, textiles and clothing, and food. Direct damages and indirect losses to the manufacturing sector in the state of Miranda were estimated at 9.360 billion bolivars.

Table 8

ESTIMATED DAMAGE AND LOSSES IN THE MANUFACTURING SECTOR
(Millions of bolivars)

State	Direct damage	Indirect losses	Total
VARGAS (includes drugstores)	8,600	7,400	16,000
MIRANDA and other affected States:	4,110	1,920	6,030
Car parts	960	400	1,360
Food	830	360	1,190
Metalworking	1,240	560	1,800
Plastics	380	200	580
Laboratories	200	100	300
Other industries	500	300	800
TOTAL	12,710	9,320	22,030

Source: ECLAC, based on official figures and those available from chambers of commerce

4. Macroeconomic effects

This section of the assessment should include background information and quantifications that will enable the macroeconomics specialist to determine the future overall effects of the disaster on the performance of the main macroeconomic variables, such as gross domestic product, balance of payments and public finances.

The industrial sector specialist must try to obtain an overview of the conditions prevailing in the sector before the disaster and of its prospects. These reference points are essential for properly weighing the future consequences of the disaster.

The information directly obtained from the affected productive units will normally be in terms of the gross value of production. This must be converted into value - added units so that the total output for the sector may be estimated. The sectoral specialist must carry out this conversion using coefficients linking one item to the other, which can be obtained from industrial censuses, some statistics and the national accounts themselves.

5. Priorities for recovery and rehabilitation

The industrial sector assessment should include a list of priority actions that affected business owners want the government to undertake to facilitate recovery. When conducting surveys of affected industrialists, industrial chambers and associations, ask for opinions on the immediate support that the sector needs for rehabilitation, both from the public sector and from abroad. Ideally, these proposals should be presented in the form of project ideas or proposals.

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C. THE COMMERCIAL SECTOR

1. General considerations

Only a brief methodological description for the assessment of the effects of a disaster on commercial activities will be presented in view of the considerable overlap with the industrial sector. However, some features of the sector are different from those of the industrial sector. Whereas commercial establishments are relatively smaller than industrial concerns on the level of personnel employed and the relative weight of machinery and equipment to personnel and to total physical assets, the opposite is true on the level of inventories.

The trend in the industrial sector toward an expansion of larger establishments to the detriment of smaller ones is even more evident in the commercial sector because of the special proliferation of supermarkets. Their rise has affected medium-sized businesses more than small ones, which have a greater chance of survival because they normally serve remote urban or rural areas.

On the other hand, information on the commerce sector is generally scarcer and less reliable than that available for industry, so the sector specialist must rely comparatively more on the opinion and judgment of the trade and professional associations of the country or region under study. For example, practically no country in Latin America has time series on the level of commercial activities, except in the case of GDP estimates, which are very broad and indirect.

In this subsection of the manual, we only make detailed references to the methodology and sources of information used when they differ from those previously described for the industrial sector.

2. Description of the affected area

Rough estimates must be obtained for the number of commercial establishments destroyed or damaged, grouped by size and type (such as supermarkets, grocery stores, fresh produce stands, footwear shops, general stores, gas stations and spare parts stores). These estimates should be based on information collected by national authorities in order to identify the area affected by the disaster.

Use of pre- and post-disaster digital aerial photographs can be extremely useful for defining the affected area and to obtaining an overview of damages sustained.

3. Direct damages

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The information available on commerce is usually so limited that detailed estimates cannot be made of the various headings under which one might otherwise list enterprises' fixed assets. Therefore, direct damage should only be broken down into three categories: buildings and facilities; furniture and office machinery; and stocks.

a) Buildings and facilities

To calculate this component, it is necessary to determine the affected surface area, whether the damage is total or partial and the replacement value as a function of the cost per square meter of construction. The latter should be adjusted to include the cost of demolition and of vulnerability-reduction components.

According to past experience, the surface area of small stores normally ranges between 50 and 500 square meters and averages around 100. These figures vary in the case of fruit stores or stalls in public markets, for example, which require approximately 12 square meters. Service stations and spare parts stores have an average of 500 and supermarkets require 1 500. The cost per square meter of the most solid constructions, such as service stations and spare parts stores, can be seven times greater than those of food stores or public markets.

b) Furniture and equipment

This component usually has relatively less weight within total fixed commercial assets than in the industrial sector, so there is no reason for the sectoral specialist to conduct an exhaustive valuation study. In past assessments, estimates stated the value of furniture and equipment as a percentage of that of buildings and facilities; the best figure seems to be 20% for small businesses and 40% for all others.

c) Stocks

The inventories of commercial establishments have a higher relative weight in total assets because these businesses are intermediaries between producers and consumers. Surveys have shown that for this specific case, stocks are usually equivalent to a maximum of two months' sales in the small-scale commercial sector. The sector specialist should compare this information to local conditions.

Furthermore, a more or less stable relationship of one to two has been observed between the value of buildings and facilities and that of stocks. This may be a function of the physical storage capacity of the facilities, although it does vary somewhat depending on the branch of commerce. Once again, the sector specialist must corroborate the local applicability of such average figures.

4. Indirect losses or effects

38 Since commerce is an activity whose main function is the provision of services, production losses incurred during the interruption of activities should be estimated not on the basis of the amount of sales not made (it is not a question of goods that could not be produced, as in the case of industry), but on the basis of profits not made. In turn, these effects should be given as value - added. Therefore, an estimate should be made of the income (or product) generated on average by each worker (vendor or owner), broken down into small, medium-sized, or large commercial establishments. Based on annual sales, an estimate may be made of losses for one or several months' of interrupted activities.

Experience shows that with proper official support, small commercial establishments can restart activities in a month, while other establishments can do so in a period that rarely exceeds six months after a disaster has occurred.

Even when the trade sector of a country is not directly affected by the disaster, its activities may be affected to varying degrees if other productive activities with which they have intermediation ties or chains have experienced damage.

Summarized information on direct damage and indirect losses caused by the floods and mudflows that affected several states in Venezuela in 1999 is provided in Table 9. The trade sector in the country had considerably diminished its output in 1999 (by around 18%), a situation exacerbated by the disaster.² Losses were estimated for the affected coastal area (mainly for the states of Vargas, Miranda and Falcón), and attention was paid to what happened in the capital and other states, where the effects were less severe. Effects in the first of the states mentioned, however, accounted for most of the damage. The coastal area's high dependence on tourism-related commerce meant that its recovery was almost completely dependent on tourism's recovery. This explains the high weight of indirect losses in the estimation of total damages.

2 Consecomerio, *Basic Economic Policies to Stimulate Internal Demand*, Venezuela, 1999.

Most of the data came from the National Commerce and Services Council (Consejo Nacional de Comercio y Servicios – Consecomercio), the La Guaira Chamber of Commerce and the specialist's own estimates carried out in the field.

It was estimated that slightly over 6 000 establishments operating in the area were affected, including large and medium-sized supermarkets, formal and informal commercial establishments covering a wide range of commercial and services activities, and over 500 customs brokers. The effects on the restaurant and recreational club facilities were dealt with separately because of their large impact in the area analyzed. In most of the cases included, damage was severe and often implied total loss of stock and facilities.

Table 9

ESTIMATED DAMAGE AND LOSSES TO THE TRADE AND SERVICES SECTOR
(Millions of bolivars)

Area and type of trade	Direct damage	Indirect losses	Total damages
State of Vargas			
Supermarkets and similar	53,950	10,790	64,740
Caraballeda (7)	4,550	910	5,460
Carayaca (5)	3,250	650	3,900
Catia la Mar (27)	17,550	3,510	21,060
Macuto (5)	3,250	650	3,900
Naiguata (2)	1,300	260	3,900
La Guaira (19)	12,350	2,470	14,820
Maquetia (18)	11,700	2,340	14,040
Other medium-sized commercial establishments (a)	132,000	33,000	164,000
Micro commerce (b)	15,000	3,000	18,000
Bank branches (44)	6,600	2,200	8,800
State of Miranda			
2 Supermarkets and 55 goods and services businesses	3,050	1,340	4,390
State of Falcon (c)	3,000	1,500	4,500
States of Sucre, Táchira, Yaracuy, and Zulia (d)	5,100	2,400	7,500
GRAND TOTAL	218,800	54,280	265,580

Source: ECLAC, based on official figures and those available from chambers of commerce.
(a) Approximately 3,000 formal commercial establishments with direct losses of 48 million bolivars each.
(b) Estimated at 3,000 premises or "small stores" with average stocks of five million bolivars each.
(c) Simply estimated.
(d) Estimated losses based on the data for states of Miranda and Falcon, considering half the losses per inhabitant for damage to commercial establishments, coefficients applied to the population of the four states mentioned in the table.

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5. Macroeconomic effects

Under this heading, the sector specialist must estimate the effects of damage and losses sustained by affected commercial establishments on local (if this information is available) and national GDP.

Disasters affect a countries' development because of their economic ramifications, which are inversely proportional to the country's economic diversification and disaster vulnerability.

As noted in the example of the assessment of direct damage and indirect losses in Venezuela, the central coastal area had a huge number of restaurants, recreational clubs, hotels, condominiums and homes, in addition to well-developed commercial and service infrastructure, all of which were destroyed to a sizable degree. A summary of all damages to non-agricultural productive sectors is presented below (Table 10).

Table 10

SUMMARY OF DIRECT DAMAGE AND INDIRECT LOSSES SUSTAINED BY
NON-AGRICULTURAL PRODUCTIVE SECTORS

Activity	Direct damage	Indirect losses	Total damages	Imported component (mill. of dollars)
	(Millions of bolivars)			
Trade and services	218,800	54,280	273,080	426.7
Manufacturing industry	12,710	9,320	22,030	34.4
Construction enterprises	640	640	1,280	2.0
Tourism	124,150	66,120	190,270	297.3
TOTAL	356,300	66,120	422,420	760.4

Source: ECLAC, based on official figures and those available from chambers of commerce

D. OTHER RELATED SUBJECTS

1. Employment and income

The cross-sectoral nature of loss of employment and income by workers and their families due to the temporary paralysis of productive activities after a disaster has been previously noted. The trade and industry sectors are no exception to this rule; indeed, some of their subsectors or activities can have a heavy negative impact on employment and family income.

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The existing relation between the output of different goods and the associated labor requirements may be determined and then applied to estimate losses of employment and income. The figures required for such estimates are normally available from labor, industry and trade ministries.

The chapter on employment and income in Volume Four of this Handbook provides details on the methodology to be used in all sectors that might be affected by a disaster. To that effect, the trade and industry specialist must work in close coordination with the specialist on employment when making such estimates. Likewise, the same type of cooperation must exist with the gender specialist when breaking down employment and income lost by women.

2. The differential impact on women

A description of how women are affected differently by disasters and the methodology for estimating this differential impact are included in the appropriate chapter of Section Five of this handbook. Each sectoral specialist is reminded to work in close cooperation with the gender specialist in this regard. Both direct and indirect damage must be estimated for women in the trade and industry sectors.

A breakdown is needed of women's private - sector assets that were damaged or destroyed by the disaster in question. Information on women's share in the ownership of industrial and commercial establishments is usually available in public statistics. Information derived from any surveys or samplings carried out to ascertain the effects on women can also be used. Once again, estimates should be broken down into large, medium-sized, small, and micro industrial and commercial enterprises. Women generally own a large share of micro and small enterprises, both in the industrial and commercial sectors.

Women often operate micro and small enterprises out of their homes to increase and supplement family income. These production activities are not always duly considered in the system of national accounts, nor can they be identified in quick surveys carried out by the trade and industry specialist because these women-run enterprises are not necessarily members of trade associations. Therefore, it is necessary to estimate damage to women-owned assets and production as a percentage of the total for formal micro and small enterprises. These damages will be over and above those estimated by the trade and industry specialist.

The gender specialist will normally carry out a quick survey among affected women to obtain figures on losses of assets and production in these types of home-based micro and small enterprises. The results of this survey must be compared with the rough estimates described in the paragraph above.

Information that must be obtained by the trade and industry specialist in close cooperation and support with the gender specialist for estimating losses caused by the disaster, is described below.

In regard to direct damages, the following information must be estimated or determined by means of quick surveys or samplings:

- Losses of assets (infrastructure, machinery and equipment and stocks) in private industrial and commercial establishments, broken down into large; medium-sized, small and micro enterprises, that belong to women; and
- Losses of assets (machinery and equipment and stocks) of family micro enterprises run by women in their homes.

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with regard to indirect losses, the following information must be obtained through estimates or samplings:

- Losses of production in formal private enterprises –large, medium-sized, small and micro enterprises– owned by women; and
- Losses of production in informal, home-based enterprises run by women in their homes.

3. Environmental impacts

One of the very frequent effects of a disaster is the uncontrolled release of toxic substances to the environment (both to the air as toxic clouds and to the ground and bodies of water).These effects are usually related to the industry and energy sectors. They are generally caused by anthropogenic activity and are considered a disaster in themselves, although they may also be a consequence of natural phenomena such as earthquakes and floods.

The environmental consequences caused by these events are quite varied and depend on the magnitude, location and type of disaster. Sometimes it will be difficult to identify the environmental impact, especially for the short term.³ Consequences of these damages can reach, directly or through “chain-link” effects, assets and flows of goods and services in several sectors.

In general, these direct damages and indirect losses are accounted for in the respective sectors. The environmental assessment specialist should work in close coordination with other members of the assessment team to ensure that these damages are duly accounted for, especially those expenses required to restore the environment. In some cases, natural areas are affected by these events; the environmental specialist will likely estimate such damages.⁴ The preferred method to assess these damages is the restoration cost method (as described in Volume Four).

³ In some cases, the interaction of certain substances with the environment is not sufficiently known, involving effects that may only occur in the very long term. In the case of floods, for example, in spite of the fact that dilution capacity of substances in water bodies increases significantly, containers of toxic substances are carried away and their contents may be released later.

⁴ Regardless of whether the sectoral specialist estimated direct and indirect damages, restoration measures may fall under the jurisdiction of institutions not directly related to the sector. In such a case, especially when environmental authorities must decide what solutions to adopt, it is likely that these expenses will not have been accounted for in the sector.

APPENDIX XI METHODOLOGICAL APPENDIX

This brief methodological appendix contains tables with examples of the type of information that the sector specialist must collect both in field research and from government authorities, chambers of commerce and professional associations.

Table 1

BASIC CENSUS INFORMATION FOR EACH OF THE NON-AGRICULTURAL SECTORS
Year: _____

Items	National	In the affected area	Share (%)
1. Number of establishments			
Large			
Medium-sized			
Small			
2. Personnel employed			
Large			
Medium-sized			
Small			
3. Fixed assets			
Large			
Medium-sized			
Small			
4. Value added			
Large			
Medium-sized			
Small			
5. Other items of interest			

Note: Criteria used to define large, medium-sized, and small establishments must be spelled out, as they may vary from country to country.

Table 2

ESTIMATE OF THE DIRECT DAMAGE TO BUILDINGS AND FACILITIES IN THE
MANUFACTURING SECTORS AT REPLACEMENT COST VALUES
(With the same characteristics in their original design)

Size/Type of enterprise/ number of establishments	Surface area affected in m ²	Average cost per m ² constructed	Total value
Total (230)			
Large (30)			
Sugar refineries (10)			
Shipyards (10)			
Man-made fibers (10)			
Food (10)			
Medium-sized (80)			
Severely damaged (50) (a)			
With minor damage (30) (a)			
Small (120)			
Severely damaged (90) (a)			
With minor damage (30) (a)			

As an example, it was estimated that the average surface area per establishment is 1,400 m² for medium-sized and 500 m² for small establishments.

Note: Figures between parentheses for the number of establishments and average surface areas for medium-sized and small establishments, as well as the specific breakdown by branches, are given only as examples and refer to the work carried out in Venezuela. The sector specialist must obtain actual figures for each case under consideration. This same estimate can be carried out using depreciated values for the condition buildings and installations were in when the disaster occurred or using reconstruction costs, including vulnerability mitigation components for buildings and facilities. The choice of estimate will depend on the specific purpose of the assessment.

Table 3

ESTIMATE OF DIRECT DAMAGE TO FIXED ASSETS AND STOCK IN THE MANUFACTURING SECTOR AT REPLACEMENT COSTS

Enterprises/number of establishments	Buildings and facilities	Machinery and equipment	Furniture and vehicles	Stock	Total
Total					
Large					
Sugar refineries					
Shipyards					
Petrochemicals					
Others					
Medium-sized					
Major damage					
Minor damage					
Small					
Major damage					
Minor damage					

Note: The breakdown by branch is presented only as an example; it refers to work carried out in Venezuela. The sector specialist must obtain real figures for each case. Damage to stocks should be determined at the replacement value prevailing under pre-disaster conditions. Depending on the aim or purpose of the assessment, damage to other assets can be estimated at their pre-disaster depreciated value; at replacement costs, with the same characteristics as their original design; or at replacement cost, including vulnerability-reduction components, in the case of buildings and facilities. The incorporation of technological advances should be considered in the case of machinery and equipment.

Table 4
ESTIMATE OF PRODUCTION CHAINS BY SECTOR AND ENTERPRISES LOCATED IN
THE AFFECTED AREA
(In local monetary units)

Branch/enterprises	Source of raw materials and inputs				Destination of final goods			
	(a)	(b)	(c)	Total	(a)	(b)	(c)	Total
Food								
Large								
Medium-sized								
Small								
Textiles								
Large								
Medium-sized								
Small								
Cement								
Large								
Medium-sized								
Small								
Other branches								
Enterprise 1								
Enterprise 2								

(a) Same area; (b) Rest of country; (c) Import/Export

Note: Information on production chains is collected to determine the indirect effects of a disaster on the main sectors or main enterprises located in the affected area. In other words, an interruption in the supply of raw materials and inputs will undoubtedly affect production flows of certain sectors or enterprises for a given time. Production chains or interrelationships can be estimated on the level of a branch or representative enterprises, as illustrated here.

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Table 5

LIST OF BASIC INFORMATION REQUIRED FOR THE ASSESSMENT
(Information usually provided by governments a few days after a disaster happens)

FEATURES OF THE NATURAL PHENOMENON THAT CAUSED THE DISASTER:

- Date of occurrence
- Duration of the phenomenon
- Definition of the phenomenon and degree of intensity
- Other characteristics of the natural phenomenon

AVAILABLE SOURCES OF INFORMATION:

- Census
- Redatam
- Periodic assessments by ministries, planning offices
- Other sources of information (including Internet)

Table 6

AFFECTED STATES OR PROVINCES AND DEGREE OF DAMAGE TO NON-AGRICULTURAL
PRODUCTIVE SECTOR ESTABLISHMENTS
(In the currency of the affected country)

Name of the state or province/size of establishments	Degree of damage		
	Severe damage (Total loss)	Medium damage (Partial loss)	Slight damage (Minor loss)
State or province 1			
Large			
Medium-sized			
Small			
State or province 2			
Large			
Medium-sized			
Small			

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Note: The government or the municipality of the affected country or area, in collaboration with competent authorities (chambers, professional associations, trade associations, etc.), should prepare this basic information to enable the sector specialist to make rapid progress in field research.

III. TOURISM

A. INTRODUCTION

1. General considerations

In most of the countries in the region, tourism is a sector that is not very well defined and whose activities are often included under other sectors in national accounts. However, in Mexico, Central America, and the Caribbean, which are frequently affected by disasters, tourism is a significant sector of the economy because of the foreign currency earnings and employment it generates. We have thus included a separate section on tourism in the Handbook.

Tourism activities may be grouped together under the following headings:

- Coastal tourism, typical of most of the islands and seafront areas in the Caribbean, Mexico, and Central America, although also found in South American countries;
- Tourism based on natural and historic heritage, commonly found in Mexico, America Central and South America;
- Marine tourism, including yachting, diving, touring on relatively small sail or motor-powered vessels, sport fishing and the like;
- Cruise tourism, traditionally very popular in the Caribbean but also extending to South and Central America in recent years;
- Winter tourism;
- Business travel;
- Family trips to visit friends and relatives; and
- Restaurant operations and activities.

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Impact assessment can be dealt with similarly for all tourism activities except for cruise tourism, which generally does not require installations other than port facilities for their operation.

In contrast to business travel, which takes place year round, tourism in the region is essentially seasonal as international tourists seek a break from the cold weather prevailing in their countries of origin. Therefore, typical tourism seasons are different for countries in the northern and southern hemispheres.

Another characteristic of tourism is that damage to infrastructure or operations caused by disasters has repercussions on other sectors. Services such as restaurants and taxis that cater to visitors are also affected. The tourist industry attends to the needs of visitors either in their country of origin (domestic tourism) or in other countries (international inbound/outbound tourism). In general terms, domestic and inbound tourism are normally more affected by a disaster, although residents of the affected country who are planning to travel abroad (outbound tourism) may also be affected.

In general, international inbound tourism has increased markedly in Latin America and the Caribbean in recent years in tandem with the industry's sustained growth worldwide. Caribbean economies depend to a high degree on tourism, while Central American economies have experienced tourism growth greater than 5% a year in recent years. Moreover, both the World Tourism Organization and the World Travel and Tourism Council foresee growth rates for the sector of 5% in the Caribbean and between 2% and 10% for the rest of the region.

International inbound tourism generates sizable foreign currency earnings, domestic and foreign investment, male and female employment and tax revenues. The sector is also linked to a wide variety of production chains for both local and imported goods and services, including ground, marine, and air transportation; communications and informatics; financial and business services; commerce; construction; and productive services in general. The sector can also lead to significant imports of goods and services not produced locally. In short, the impact of a disaster on the sector has ramifications for other sectors.

Tourism must be sustainable over time, meaning it needs a range of attitudes, behaviors, strategies, plans, laws and regulations in response to economic, social and environmental needs. A comprehensive tourism policy is required to enable an improvement in the country's economic opportunities, which benefit communities and enterprises, and to contribute to personal, social and economic growth for men and women.

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2. Tourism and vulnerability

Throughout the region, tourism facilities have sprung up in many destinations without proper planning for ecological and vulnerability concerns. The resulting facilities are often located in hazardous areas due to the absence of environmental management and natural resource land-use regulation, as well as a lack of adequate construction standards or regulatory compliance in hotel infrastructure and related human settlements. To a large degree, tourism depends on the preservation of the environment and of cultural, social, and historical heritage. Therefore, the effects of disasters can be aggravated if the aspects mentioned above are not strictly addressed.

It is well known that in some areas or regions –such as the Caribbean or Central America– the tourism developments most frequented by international vacationers are highly exposed to natural phenomena with significant hazard risk. The best tourism destinations in the region are frequented by tropical storms and hurricanes, as well as floods and earthquakes. Although vulnerability varies from one country to another, the fragile nature of the land and marine ecosystems in the region is obvious, as is the lack of suitable environmental management, disaster-aware land-use planning and building standards.

Other long-lasting natural phenomena, such as droughts and prolonged eruptions of volcanic ash, can indirectly affect tourism through the national supply chain –farming and agribusiness, or even access to water for human consumption– or by reducing the comfort foreign tourists experience. When supplies are stressed, the industry may suffer from resentment among a local population denied basic services while foreigners receive privileged treatment.

The sector is also exposed to another type of vulnerability related to the volatility of demand. News of a real or potential disaster can prompt immediate cancellation of reservations by foreign tourists and diminish future tourism flows and income for a long time.

3. Sources of information

The tourism sector specialist can use various domestic and international sources to obtain reliable information both on the pre-disaster situation and on the damage caused by the action of the underlying phenomenon.

Domestic information sources include the following :

- Recent censuses or surveys on tourism spending and stays;
- National statistics offices;
- Information provided by national tourism sector authorities;
- Hotel and tourism associations;
- Tour operators;
- Central banks;
- Port and airport authorities; and
- Insurance companies.

Useful international sources include, among others, the following:

- Central American Tourism Integration Secretariat;
- Caribbean Hotel Association;
- Caribbean Tourism Association;
- International reinsurance companies; and
- World Tourism Organization.

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Reviews of the information published by these international bodies and field visits to the aforementioned local institutions will allow the specialist to gather information on the situation both before and after the event.

B. ESTIMATION OF DAMAGE AND LOSSES

As in other sectors, it is necessary to estimate direct damage to assets and indirect losses in economic flows derived from tourism. Afterwards, it will be necessary to calculate the impact on the main macroeconomic variables (e.g., gross domestic product, foreign accounts and public finances), employment and the differential effect on women.

1. Direct damages

As a first step in estimating the direct damage to the sector, it is necessary to establish the baseline. This refers to tourism-specific assets that are not included in any other sector, and it requires detailed information on items such as the number and capacity characteristics of several types of establishments:

- Hotels, by category;
- Guest houses or family-run establishments;
- Cultural and historical attractions;
- Docks and jetties;
- Vessels or transportation vehicles;
- Winter tourism facilities; and
- Restaurants.

The tourism specialist may use such data as a basis for comparison when assessing direct damage to the infrastructure and equipment of the sector. The area affected by a disaster may be superimposed on this baseline as the first step in damage assessment.

Estimating direct damage for the tourism sector is essentially the same as for the housing sector, and what was indicated in that chapter will not be repeated here. In the case of tourism facilities, equipment might include water collection and purification works, wastewater collection and treatment plants, electricity generators and large-scale air conditioners. Likewise, any damage to the sector's transportation infrastructure and equipment should be included –docks, leisure vessels and other works– so the tourism specialist must work closely with the transport and communications specialist to make his/her work easier and to avoid double accounting. Moreover, the tourism specialist must make estimates –once again, in close cooperation with the environmental specialist– on the impact on natural resources that make up the tourism environment, such as erosion or silting of beaches. Undoubtedly, these estimates will be specific to the sector in some cases, whereas in other cases cooperation with other sector specialists will be essential.

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It should be noted that beach erosion is common in the case of tropical storms and hurricanes in the Caribbean and Central America. Nature tends to return the beaches to their pre-disaster condition, but the process may be a lengthy one.¹

2. Indirect losses

As in the case of direct damage, the tourism specialist must obtain basic information on the pre-disaster conditions for making comparisons against the post-disaster situation.

In this regard, the specialist should obtain the following information for each of the categories of establishments or recreation and tourism transportation equipment noted above:

- Number of rooms, listed by capacity;
- The occupancy rate of each type of room and changes over time (the demand curve);
- Number of restaurants and their capacity;
- Capacity of vessels and average occupancy during the tourism season;
- Employment –by type of job or trade and by sex– needed to operate each type of establishment; and
- Volumes of inputs of all types –food, drinks, etc.– that must be imported for the operation of each type of establishment and vessel.

¹ Hurricanes Luis and Marilyn significantly damaged the beaches of Anguilla in 1995. A later visit to the island in 1996 revealed that the sand had almost returned to normal thanks to the action of the tides.

The tourism specialist must estimate, in close consultation with the owners of establishments or trade associations, the time needed for a return to pre-disaster conditions. Such a projection, in conjunction with occupancy and demand-curve data, makes it possible to estimate the loss of income the industry is likely to suffer (i.e., the main indirect losses).

The tourism specialist must also consider other types of indirect damage, including the possible cancellation of reservations from abroad and the possible cost of a promotional campaign to once more attract tourists.

The cleaning of beaches damaged by tides, floods or winds, and of paths used in ecotourism must also be counted as indirect damage.

It is necessary to calculate the extent of probable tourism occupancy reduction resulting from damage to other related sectors, such as access roads, water and sanitation systems, power availability and communications systems.

Any decrease in tourism activity also implies a diminished demand for related services such as the use of restaurants, nightclubs and taxis.

One last type of indirect damage that must be taken into account by the tourism and other sector specialists is the increase in insurance premiums that companies often charge in the wake of a disaster in anticipation of a possible recurrence of such extreme natural phenomena. The increased premiums could lower the income and operational profitability of tourism establishments.

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In the case of cruise tourism –so popular and common in the Caribbean– certain additional estimates must be carried out. Since cruise liners schedule their ports of call well in advance, it is possible to estimate the income each of those tourism sites would have been likely to post had the disaster not occurred. Any natural event that damages port infrastructure, natural resources or commerce in a tourism destination can cause immediate cancellations by cruise ships. Interviews with national authorities, businessmen in the sector and representatives of the cruise lines can allow the analyst to project how long it will be before the ships are likely to return, thereby making it possible to calculate the corresponding (indirect) loss in income.

3. Macroeconomic effects

We have already noted that officials in many countries in the region register tourism as part of accounts for other sectors; tourism satellite accounts are not yet common practice or might not be sufficiently updated or broken down by activity or region. In addition, the heterogeneous nature of tourism means that many of its components fall within the sphere of other sectors, such as infrastructure, communications, commerce and the like. Despite such potential obstacles, and in light of the economic weight of tourism in the Caribbean and increasingly in Central America, Mexico and elsewhere in the region, it is necessary to conduct a separate assessment of tourism's macroeconomic impact.

Such an analysis must include calculations of how a disaster's impact on the sector would affect economic output, external accounts, and public finances, with proper attention given to the effects on public and private investment, employment and women.

a) Effects on economic activity

Forecasts of how tourism would have performed in the year in question, had there been no interruption in activities due to the disaster, are normally available in national planning offices, central banks or sector agencies.

The tourism specialist should compare this information with estimates on decreases in income as estimated in the section on indirect losses, and then estimate a new economic output (contribution to GDP) for the tourism sector after the disaster. Special care must be exercised to ensure that these estimates do not lead to double accounting should other specialists include tourism activities in their sectors. (In the cases of small Caribbean economies in which income from tourism is high, potential duplications are unlikely).

It should also be noted that tropical storms and hurricanes that cause damage to the sector in the Caribbean usually occur during the low tourism season. Therefore, indirect losses due to drops in occupancy rates and the subsequent effect on GDP are not necessarily significant, unless the reconstruction period for damaged infrastructure is very long.

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b) Effects on the external sector

International inbound tourism has a special impact on the external sector. If the relative weight of tourism in the economic activity of the affected country is significant, any drop in tourism activities due to a disaster will imply major reductions in foreign-currency revenue (from the export of services). The tourism sector specialist should estimate such decreases in revenue from abroad.

Another heading that the tourism specialist should take into consideration is the possible availability of insurance or reinsurance policies on goods destroyed or damaged in the tourism sector since they can generate an unforeseen inflow of foreign currency. In addition, the rehabilitation and reconstruction of hotel and restaurant infrastructure, and the replacement of their equipment and machinery, might require significant imports, especially if they are not produced in the affected country. Once again, the tourism specialist must make the corresponding estimates.

These calculations should be delivered to the macroeconomics specialist so that he/she can combine them with those of other sectors and determine the overall effect of the disaster on the external sector of the affected country.

c) Effects on public finances

Although the current trend in the region is for tourism sector infrastructure to be privately owned a disaster can have major effects on the finances of an affected state.

Indeed, the natural phenomenon may directly affect transportation, port and airport infrastructure (which is normally publicly owned), further diminishing tourism income. However, such estimates of damage to infrastructure are usually taken into consideration in the respective sectors.

The main negative effects on public finances caused in the tourism sector stem from the drop in revenue from taxes and fees paid by , which the country will not collect during a certain period. This loss of state revenue can be estimated on the basis of the drop in hotel demand or occupancy previously estimated as indirect losses.

In addition, the state might be forced to make unplanned outlays to overcome problems in the tourism sector, such as beach and forest path cleaning work, special benefit payments to persons who lose their employment in the sector and so forth.

The tourism specialist must make these estimates and provide them to the macroeconomics specialist who, after ensuring that there is no duplication with the information from other sectors, will use them to obtain the total impact of the disaster on public-sector finances.

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d) Effects on investments

The impact on public or private investment may vary depending on the magnitude of total damage relative to the size of the economy of the affected country or region.

The occurrence of a disaster and the subsequent rehabilitation and reconstruction may produce several effects. First, uncertainty as to the likelihood of hazard prevention and mitigation works may discourage investment decisions and inflows. Second, public and private investment programmes may be modified and increased to meet the needs of rehabilitation and reconstruction. Third, the need to replace lost assets may take precedence over projects previously designed to overcome long-standing social shortcomings; the resulting programme postponements and cancellations imply a social cost.

Although these observations are valid for all sectors, the tourism specialist must provide the macroeconomist with all information that can be obtained in this regard, so that he/she may get a clear overview of possible changes in the behavior of the economy of the affected country.

4. Effects on employment

When tourism activities are reduced, there is a corresponding decrease in the employment and income of men and women working in the sector. A relationship exists between the income generated in the sector and the number of various types of employees with their different income levels. Therefore, it is possible to estimate job losses in the sector based on the estimates of industry activity and income during and beyond the rehabilitation and reconstruction stage. This loss can be partially compensated by the use of tourism sector workers in cleaning and infrastructure recovery tasks, since both employers and employees wish to ensure that the same labor force will be available once the emergency is behind them and normal tourism activities resume. The tourism specialist should make these estimates in close cooperation with the employment specialist.

In very small economies, the labor force available in the construction sector may be insufficient to quickly carry out the reconstruction that hotels require. In such cases, labor, machinery and equipment have been imported from abroad, and these will not necessarily return to their countries of origin after reconstruction is completed, possibly aggravating pre-existing employment problems. The tourism specialist must be aware of this type of potential dilemma and quickly report it to the macroeconomics and employment specialists.

5. The differential impact on women

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As in other sectors, women's share of tourism is affected by disasters. Tourism facilities and services affected by a disaster may be owned by women; other women might temporarily lose their employment in the industry.

In this regard, the tourism specialist must co-operate closely with the gender and employment specialists to determine three key points:

- Women's share of sector ownership;
- Women's share in the sector's labor force; and
- The possibility of including women in rehabilitation and reconstruction tasks.

The required information may be obtained from censuses, recent household surveys, chambers of tourism statistics and so on. The results of this analysis must be delivered by the tourism specialist both to the macroeconomist and to the gender specialist, who will be responsible for adding the figures from all sectors to determine the differential impact of the disaster on women at the national level.

6. Environmental impact

The methodology for assessing damage to environmental assets and flows in environmental goods and services is described in the chapter on the environment in Volume Four of this Handbook. A significant portion of the tourism industry is based on the environmental services of recreational opportunities and scenic beauty, both in the case of highly intervened environments (usually the case of sun and beach tourism) and the less intervened environment (usually the case of the tourism in protected areas, sometimes called ecotourism).

Therefore, damage assessment in the tourism sector and environmental damage assessment are closely related. In terms of quantification and valuation of damage, two different situations may occur (see the chapter on the environment).

a) Environmental damages usually included in tourism sector assessment

This heading refers to direct damages and indirect losses (loss of natural capital and changes in the flows of environmental goods and services) that are already accounted for in the tourism sector. Beach loss and degradation, lodging infrastructure damage and drops in revenues that occur during the restoration period are good examples of these losses. The environmental assessment tries to identify the share of these damages corresponding to the contribution of natural capital, isolated from contributions of human capital and other assets such as infrastructure and equipment. Estimation of this contribution can be made using the economic rent concept (the difference between market prices and production costs). However, it is not easy to estimate this contribution in the tourism sector, except in the cases of fees charged to enter protected areas and taxes used for environmental protection (e.g., additional airport or room taxes that are levied on foreign visitors in certain countries). To avoid double accounting, these estimates should be included in only one sector (either tourism or environment) in the damage overview.

b) Separate quantification and valuation

This case refers to the valuation of assets and environmental services related to tourism activities that are not accounted for in the tourism sector assessment. Examples include, the valuation of environmental changes in ecosystems relevant to the tourism sector such as forests, coral reefs or damage to emblematic species. These damages should be included in the damage overview, as they have not been considered in the damage assessment of the tourism sector.

APPENDIX XII

THE IMPACT OF HURRICANE KEITH ON BELIZE'S TOURISM SECTOR IN 2000

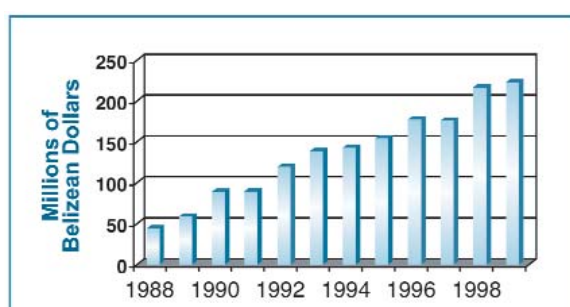
The following is ECLAC's estimate of the impact caused when Hurricane Keith passed through Belize in late 2000.²

General information

Hurricane Keith caused significant damage to tourism, which is the main sector in Belize's economic activity. According to the World Tourism Organization, in 1996 tourism accounted for 14.3% of GDP. It is also the country's leading exporter, generating income of 88 million US dollars in 1998, almost twice as much as sugar, which ranks second.

Figure 1

Tourist expenditure, 1998 - 1999



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Tourism has developed at high growth rates in the last decade (see figure 1): Tourist arrivals have almost doubled, and tourism infrastructure and activities have been expanded significantly.³ The tourism products on offer are linked to Belize's cultural and environmental heritage: tropical rain forests, biodiversity, historical buildings and marine life.⁴ Seventy percent of tourists come from the United States and Canada, and 23% are from Europe.

In terms of income per hotel room, the most important areas are Ambergris Cay (43.1% of the total), the Belize District (23.6%) and the Cayo District (10.7%).⁵ The high season for tourism runs from December to Easter.

² ECLAC, *Belize: Assessment of the Damage caused by Hurricane Keith, 2000: implications for Economic, Social and Environmental Development*, Mexico City and Port of Spain, November 2000.

³ Between 1990 and 1999, the number of hotels increased from 210 to 390, and the number of hotel rooms rose from 2,115 to 3,963.

⁴ According to a survey of visitors in 1997, marine attractions were their main reason for coming to Belize.

⁵ The Belize Tourism Board receives a 7% tax on income from each occupied hotel room.

Direct damages

The winds and high seas produced by Hurricane Keith devastated the cayes of northern Belize, especially Ambergris Caye, Caye Caulker and Caye Chapel. Most of the hotels (62 on Ambergris and 37 on Caulker) sustained differing degrees of damage to their infrastructure and equipment. Inland, however, the damage was less severe. The Mayan archaeological site in the Lamanai Nature Reserve was damaged by high winds, fallen trees and flooding, and fissures appeared in the main pyramid.

The northern cayes sustained the following damage:

- Total destruction of two hotels on Caye Caulker and one on Ambergris and structural damage to several others;
- Damaged roofs on a large number of the hotels, which led to damage to their interiors, including ceilings and furniture;
- Damage to equipment (pumps, water heaters, washing machines, air conditioners);
- Damage to the landscape caused by the loss of trees and depositing of residues;
- Damage to gift shops and restaurants;
- Damage to the Caye Chapel golf course;
- Quays completely or partially destroyed;
- Jetties destroyed in Caye Chapel and Caye Caulker;
- Land lost from beach erosion (included under the heading of environmental damage and loss); and
- Loss of boats used for the tourist trade.

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An assessment was made of the cost of replacing destroyed infrastructure and repairing that which was only damaged, as well as of replacing lost boats. It was based on official information supplied by Belizean authorities and local insurance companies.

The total amount of direct damage was estimated at 62 million US dollars. The following table contains a breakdown of estimated direct damage.

Table 1

ESTIMATE OF DIRECT DAMAGE TO THE TOURISM SECTOR CAUSED BY HURRICANE KEITH

Heading	Miles of USD
Country Total	62,047.0
Hotel buildings, including furniture, equipment, and golf course	42,000.0
Souvenir shops	5,000.0
Restaurants	5,600.0
Landscape	1,280.0
Quays and marinas	567.0
Piers and connected works	5,200.0
Tourist boats (140)	2,100.0

Source: ECLAC, based on official figures

Indirect losses

Indirect losses caused by the hurricane to Belize's tourism sector includes the following:

- Lower hotel occupancy (on Ambergris Caye and Caye Caulker);
- Lower tourist expenditure, including food and beverages, local transport and recreation;
- Lower revenues from country exit taxes;
- Unforeseen expenditure on promotion overseas to counteract the negative information about the effects of the hurricane published in the international press; and
- Cost incurred by some hotels to purchase emergency generators to make up for the lack of electricity after the hurricane.

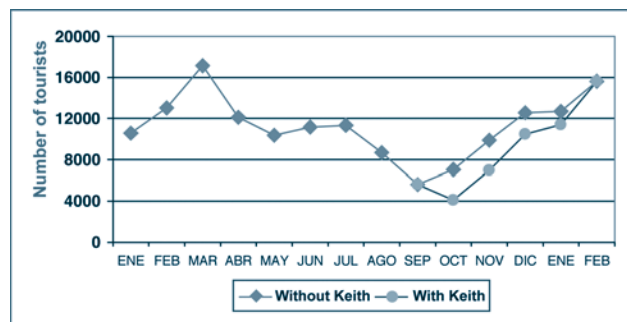
Fortunately, there was no decline in cruise tourism, nor were hotel room rates lowered.

A study was made of possible tourist arrival behavior, bearing in mind both its seasonal nature and the trends detected in 1998 and 1999 in the wake of Hurricane Mitch. It was estimated that recovery would take four months, which was the projected period for the overseas promotional campaign to produce results. In other words, it was estimated that the country's tourism would return to its forecast levels by February 2001 (see figure 2).

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Figure 2

ANALYSIS AND PROJECTION OF TOURIST ARRIVALS IN BELIZE BEFORE AND AFTER HURRICANE KEITH.



Existing data showing the relationship between the number of tourists arriving in the country and their expenditure on various related services were used to make an estimate of total indirect losses. On this basis, the total indirect damage to the sector was estimated at 18.15 million dollars (see the table 2).

Table 2
ESTIMATE OF INDIRECT DAMAGE CAUSED BY HURRICANE KEITH IN BELIZE
(Thousands of US dollars)

Heading	October	November	December	January	Total
Sector total					18,149.5
Decline in hotel occupancy	2,496.3	2,462.6	1,780.0	1,077.9	7,816.7
Decline in consumption of services					9,553.8
food	998.6	985.0	712.0	431.1	3,126.7
local transport	665.7	656.7	474.7	287.4	2,084.5
recreation	665.7	656.6	474.7	287.4	2,084.4
local purchases	443.8	437.8	316.5	191.6	389.7
other expenditure	277.3	273.6	197.8	119.8	868.5
Reduction in exit taxes					242.2
Additional energy cost					536.8

Source: ECLAC estimates based on official figures

The above estimates were made using information provided by the Belize Tourism Board, which indicates that on average a tourist remains in the country for 7.1 days and that room rates in 1999 in the damaged hotels on Ambergris Caye and Caye Caulker were 179.84 and 51.12 Belizean dollars, respectively. A survey of tourist spending made by the Tourist Board in 1997 showed that it was distributed as follows: lodging (45%), food and beverages (18%), local transport (12%), recreation (12%), purchases (8%) and other expenses (5%). With regard to exit taxes, account was taken of the fact that a tax of 20 US dollars is charged at the airport, while only 10 US dollars is charged at other points of exit. Finally, we took into account the fact that 20% of the hotels on Ambergris and Caulker invested an average of US 1 350 per room in emergency generators.

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Total damage and losses

After adding indirect and direct damages together, it was estimated that total damage and losses caused by Hurricane Keith in Belize amounted to 80.2 million US dollars. Direct damage accounted for 77% of the total (62 million dollars) and indirect losses for the remaining 23% (18.2 million dollars).

Macroeconomic effects

Damages sustained by the tourism sector also had a significant effect on Belize's macroeconomic performance. Not only did the growth rate for the sector and for the economy in general decline, but there was also a negative effect on the balance of payments.

The tourism sector was responsible for a significant part of the one-percent decline in the growth forecast for the national economy as a whole in 2000. The cost of repairing the damage caused to the tourism infrastructure, together with the decline in the sector's income, reduced the balance of payments by 57.6 million US dollars. This figure consists of imports of non-domestically produced materials and equipment used for reconstruction, as well as foreign currency lost because the expected number of visitors failed to arrive.

Effects on employment and income and on women

The worst flooding caused by the hurricane occurred in the rural areas of the Orange Walk and Cayo districts, two of the areas in the country where poverty is greatest. Damage to tourism infrastructure and services, which can be measured in monetary terms and which in any case was largely insured against, had relatively less tragic consequences than that caused in these districts.

Between 25% and 38.5% of households in Orange Walk and Cayo are headed by women. Rates of female unemployment and fertility are high, especially for women younger than twenty-five. There seems to be a correlation between poverty in these areas and the high incidence of transmissible diseases.

It is estimated that 33% of Belize's population has an annual per capita income of less than 645 US dollars and that income in the rural areas amounts to only 42.5% of this figure. The continuous flow of refugees from neighboring countries to the south of Belize is increasing the number of inhabitants living below the poverty level, and the incidence of poverty is growing in the rural districts and among the most vulnerable groups of the population. Average lost income among the population in these depressed areas was estimated to have reached the sum of 239 US dollars per capita.

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There is no doubt that the hurricane had a severe negative impact on the government's efforts to reduce poverty in the country. The strategy under execution before the disaster entailed reducing the fiscal deficit to less than 2% of GDP. Estimates show that the deficit will now reach 3%, which means that poverty reduction targets will be set back. Additionally, any attempt to keep to the targets set before the disaster would endanger the currency's exchange rate.

Handbook

for Estimating the Socio - economic and Environmental Effects
of **Disasters**

Economic Commission for Latin America and the Caribbean
ECLAC

Section Five

Overall effects of damages

I. ENVIRONMENT

1. General considerations



As is well known, a people's quality of life and well-being depends to a great extent on the state of the environment. Ecosystems provide a range of goods (such as food, water, medicines and energy) and services (such as the dilution and transformation of waste, the regulation of the water cycle, carbon sequestration, the maintenance of biodiversity and recreation) that sustain and satisfy human life (see Table 1).

From an economic perspective, natural resources are considered assets (natural capital) from which goods and services are derived that help increase people's well-being. From this point of view, natural resources have a use value.¹ Natural heritage can also generate values unrelated to any direct or indirect use. These non-use values arise from the psychological benefits derived from, among other things, the mere knowledge that the resource exists (existence value) or the wish to preserve natural capital for future generations to enjoy (inheritance value).

1

Extreme events are part of nature, and ecosystems have evolved with them. For example, many ecosystems have adapted to occasional wildfire favored by drought: phytophytic species in these ecosystems actually require fire for proper germination. Riverine habitats and ecosystems are often dependent on annual floods. When these events occur in remote areas without human intervention, they are not considered disasters.

However, where natural and human systems interact, qualitative and/or quantitative environmental change that detracts from people's well-being can result from extreme natural phenomena.

¹ Direct use values derive from the consumptive use (for example, the use of firewood) or non-consumptive use (such as tourism activities) of natural resources. Indirect use values, also known as functional values, can be described as the benefits indirectly enjoyed by people as a result of the primary ecological function of a given resource. For example, the indirect use value of a wetland can derive from its contribution to the filtration of water used downstream.

For example, a hurricane can cover a beach with debris and prevent its recreational use; flooding can lead to contamination by wastewater; drought might affect the survival of an endangered species. Such environmental change can be permanent or temporary. A volcanic eruption with lava flows can result in irreversible changes in the landscape; however, changes in the atmosphere caused by the same eruption, such as pollution by the gases released, are temporary. Changes in people's well-being might arise from the temporary or permanent inability to use environmental goods or services, or the increased costs of their enjoyment without there being environmental change. For example, the destruction of a path leading to a beach might prevent (or make more costly) its recreational use even if the beach did not undergo environmental change.

Table 1
GOODS AND SERVICES PROVIDED BY ECOSYSTEMS

Ecosystem	Goods	Services
Agroecosystems	Food crops Fibre crops Crop genetic resources	Maintain limited watershed functions (infiltration, partial soil protection) Provide habitat for birds, pollinators, soil organisms important to agriculture Build soil organic matter Sequester atmospheric carbon
Forest ecosystems	Timber Fuelwood Drinking and irrigation water Fodder Nontimber products (honey, fruit, spices, plant medicines, hunting, etc.) Genetic resources	Remove air pollutants, emit oxygen Cycle nutrients Maintain array of watershed functions (infiltration, purification, soil stabilization) Maintain biodiversity Sequester atmospheric carbon Moderate weather extremes and impacts Generate soil Provide for aesthetic enjoyment and recreation
Freshwater ecosystems	Drinking and irrigation water Fish Hydroelectricity Genetic resources	Buffer water flow (control timing and volume) Dilute and carry away wastes Cycle nutrients Maintain biodiversity Provide aquatic habitat Provide transportation corridor Provide for aesthetic enjoyment and recreation
Grassland ecosystems	Livestock (meat, leather, etc.) Water for human consumption and irrigation Genetic resources	Maintain array of watershed functions (infiltration, purification, soil stabilization) Cycle nutrients Remove air pollutants, emit oxygen Maintain biodiversity Generate soil Sequester atmospheric carbon Provide for aesthetic enjoyment and recreation
Coastal ecosystems	Fish and shellfish Fishmeal (animal feed) Seaweeds (for food and industrial use) Genetic resources	Moderate storm impacts (mangroves, barrier islands) Provide wildlife (marine and terrestrial) habitat Maintain biodiversity Dilute wastes Provide harbours and transportation routes Provide for aesthetic enjoyment and recreation

Source: World Resources Institute (2001)

In Latin America and the Caribbean, national accounts do not yet expressly include most environmental assets and services. In other words, environmental accounts have not yet been included in the national accounts of countries, although some of the value of environmental services is included in the statistics of such sectors as agriculture, and tourism. Consequently, damage assessment methods in the past did not include estimates of the effects of disasters on the environment. Nevertheless, such estimates can be made by way of a series of indirect procedures.

Our proposed methodology of environmental damage assessment takes into account several major constraints, such as the scarce time available for carrying out the assessment, the lack of information on affected ecosystems and the paucity of markets for most environmental services. Moreover, environmental economics has only recently developed as a subdiscipline within economics, with much room for innovations and improvements in tools and methodologies for environmental valuation.

To undertake such an analysis, concepts must be defined in line with the ECLAC methodology and applied to the specific case of the environment, its assets and its services. Environmental capital or assets are made up of the ecosystems that provide society and economies with environmental goods and services. To assess the effects of a disaster on natural capital, one can begin by separating its components: physical medium (soil, water, air, climate); biotic medium (human beings, flora and fauna); perceptual medium (landscape, scientific and cultural resources); and interactions among the above-mentioned media. Thus, the environmental changes caused by a disaster can produce direct damage to such assets or to works built to take advantage of them; they may also lead to indirect losses when the related environmental services are reduced, diminished in quality or made more expensive.

Direct damage to the environment can be estimated as the value of the assets affected. If there is permanent destruction, direct damage can be considered to be close to the commercial value of the assets when a market exists for them. When there is no such market and a reversal of the environmental change is deemed appropriate, the direct damage can be approximated by estimating the cost of rehabilitating or recovering the assets. For example, if agricultural land is completely destroyed and restoration is not deemed appropriate (whether for technical or economic reasons), the direct damage will be the value of the land. If there is hillside erosion, direct damage can be estimated based on the cost of stabilizing the slopes through soil conservation works.

The presence of values not associated with use of the environment (such as existence values) and the lack of markets for many environmental goods and services pose theoretical and practical obstacles to conducting any economic valuation. When a value cannot be assigned to assets for the estimation of direct damage, estimates must be made by indirect means. For example, the direct damage to soils caused by mudslides can be estimated as the agricultural or forestry production precluded for a period sufficiently long to constitute a total loss. When damage to assets can be recovered naturally over a given period, the value of the damage can be estimated indirectly by measuring the amount of the environmental services the assets will not provide over the period required for recovery.

3

The many and varied cases of harm or damage must be analyzed individually to define or choose the method for estimating both direct and indirect damage to environment. These are described in the sections below, broken down into the procedures for each of the assets or resources mentioned above. Bear in mind that most of the damage estimated in this way will already have been measured or determined under the different social or economic sectors, and care must be taken not to count them twice at the moment of the damage review.

2. Assessment procedure

To carry out the economic assessment of the impact of a disaster on the environment, the environmental specialist must follow a procedure of successive stages in close co-operation with the sectoral specialists and the macroeconomist. Those stages are as follows:

- i) Description of the environmental state before the disaster, representing the baseline for assessment;

- ii) Identification of the impacts of the natural disaster on the environment;
- ii) Qualitative environmental assessment;
- iv) Classification of the effects on the environment;
- v) Economic valuation of the environmental impact; and
- vi) Overlap with other sectors.

The following sections describe each of these stages.

a) Description of the state of the environment before the disaster

To properly attribute the effects that really are due to the disaster, the pre-existing environmental situation must be appraised.² This stage consists of collecting, classifying and describing the environmental conditions involved (resources, natural or artificial systems, biodiversity) specific to the area in question and other areas included within the perimeter officially recognized as affected.

4 Apart from serving to correctly attribute the effects of the disaster, this process contributes to the analysis of possible links between the scale of the damage caused by the disaster and environmental deterioration prior to the event. For example, in the assessment of the damage caused by Hurricane Mitch in Central America (October 1998) it was established that the severe effects of the rains were aggravated by the previous actions of humans and previous disasters (The El Niño phenomenon of 1997-1998), such as deforestation and the loss of plant cover on slopes, inappropriate land use and the presence of human settlements in such risk areas as flood plains and mountainsides. The comparison of the effects of an extreme natural event between areas with greater and lesser degrees of environmental deterioration highlights the role played by the state of the environment in mitigating or intensifying damage.

Basic information to be collected. The environmental specialist will use a series of elementary steps, duly recording information, in a log or protocol and noting the date and source. These records serve not only for his or her own information but also to enable follow-up and application in similar, later assessments. This method must be based on the following steps:

Gather and collect basic material and bibliographic sources relevant to the problem and area in question, employing personal, library and institutional databases, primary, (books, official reports by independent institutions, NGOs, international institutions, United Nations institutions, foreign-aid banks, private enterprises) and secondary sources (newspaper and magazine articles, Internet sites, etc.);

² In the case of long-duration disasters (such as droughts), the baseline will be represented by the closest approximation possible to what would have been the situation without a disaster. If the comparison is made with the situation before the disaster, effects due to another type of cause could be attributed thereto. If, for example, the area affected by forest fires is being assessed in the context of a drought, the area affected by forest fires in a normal year must be taken into account (if the information is available). The difference between these two values is what should be attributed to the drought.

Access directories of government institutions and NGOs that list contacts, project heads, spokespersons or ad hoc representatives that are relevant to the study of disasters;

Establish a plan of personal interviews (see following step), in coordination with relevant and appointed national contacts;

Meet with people in positions of responsibility, appointed technical specialists and other figures with knowledge and responsibilities or information relevant to the case in question;

Access laws and regulations while assuring familiarity with the legal framework of the country, state or region in environmental management, environmental control, watershed management, environmental conservation, and biodiversity, as well as in emergency prevention, institutional coordination and preparation, and reconstruction in general (works, infrastructure, environment);

Prepare a plan and guide field studies of affected areas and, if possible, of unaffected and/or pristine areas;

Conduct field interviews with officials, government spokespersons and community leaders while appraising other on - site studies or existing assessments;

Indicate how those factors for which no information exists were studied and quantified by the expert or group of advisers; and

Determine the steps to be followed to improve information and valuation.

Desk study. The desk study and assessment are carried out day by day, before and after meetings with the other specialists participating in the damage assessment, using the information available up to that moment. The first condition for an appraisal of the environmental quality of the area or district affected by the disaster is having access to good, sufficient and reliable information. The availability of quality information depends mainly on the country affected. The following should be used:

Environmental profiles and natural histories;
Reports on past disasters and preliminary reports on the disaster in question;
Maps of potential and actual wildlife and plant life areas, and of potential and actual land use;
Geological and geomorphological maps and reports;
Maps of weather and hydrogeological conditions;
Geographic information systems (GIS) at scales of 1:200,000 and 1:50,000 for large areas and several watersheds; in some cases a 1:10,000 or 1:5,000 level is appropriate; and
On - site, aerial or satellite photographs or films, relief maps (detailed logs must be kept of field trips to affected areas and to similar unaffected areas for purposes of comparison).

All this material will enable reasonably accurate definitions of the state of the environment before and after the disaster occurred. Gathering this information will allow the environmental specialist to undertake the comprehensive qualitative and quantitative study.

Definition of the areas and aspects of greatest interest. An initial screening should determine the points of greatest interest or importance, so that analysts can focus research and assessment on what is most representative of the problem. This is necessary because the time the group of specialists has available for the assessment is almost always very limited by mission cost considerations and the urgent need for post-disaster information. The scope of the study is almost always established within the first two or three days of the mission, after the most important environmental characteristics of the affected area and the probable impact have been taken into account.

- 6 If an environmental study group is available, each specialist should concentrate on the environmental variables in his or her professional field; their results can be combined later. A list or basic framework of systems, habitats or species important to each wildlife region (including protected areas that were affected) should be prepared. The most representative ecosystems and their pre-disaster level of environmental service provision (for example, water production CO₂ sequestration, biodiversity, ecotourism) must be taken into account. The chosen variables must be measured on site within the areas of influence in accordance with the behavior patterns and structure of the system where the phenomenon arose, thereby providing a general framework or scenario of the state of the environment.

The characteristics or value of the environment in question must be determined in line with the most important qualities and properties of natural resources, species and/or environmental services.³ When determining the quality of ecosystems and environmental services, one must consider at least the following:

- Unique or unusual land formations;
- Protected areas or ecosystems (official or private);
- Wildlife areas strategic to a region;
- Areas important for the maintenance of natural systems (egg-laying, hatching, birthing and breeding areas; water collection areas, vital support systems) located outside of the country or region in question;
- Areas important for the maintenance of species useful to agriculture, fish-farming, animal raising, and so on;
- High-quality or unique communities of endemic plants or animals;
- Communities of plants or animals that can be used for repopulation and ecological restoration;
- Rare or unique habitats;
- Biological corridors;

³ Inserts can be used to highlight questions of special interest. For example, in the assessment of the effects of Hurricane Keith in Belize (2000), an insert was included on the main characteristics and human pressures of one of the most important ecosystems in the region: The Meso-American reef system. See ECLAC, *Belize: Assessment of the Damage Caused by Hurricane Keith, 2000: Implications for Economic, Social and Environmental Development*, (LC/MEX/G.4 y LC/CAR/G.627), Port of Spain, Trinidad and Tabago, 2000.

Highly diverse biological communities;
 Highly productive habitat (woodland, wetland, estuary, reef, etc.);
 Refuge habitat for rare or endangered species;
 Habitat for species that need large territories;
 Area of seasonal importance to the feeding or reproduction of one or more species;
 Areas that maintain a wild bank of domesticated species;
 Habitat of great scientific or educational value;
 Habitat of traditional importance for the provision of fuel, fabrics, food, construction materials or traditional medicine;
 Areas of historic, cultural, religious or archaeological interest; and
 Micro/meso/macro areas of aesthetic, landscape and recreational value.

b. Impacts of the disaster on the environment

The different types of natural hazards involving dynamic forces that change the earth's surface can be classed into two well-defined categories. First, internal geodynamic phenomena are governed by endogenous geophysical forces and processes that are part of the earth's crust; these include seismic and plate-tectonic activity, intra-plate activity, and volcanism. Second, hydrometeorological phenomena are mainly governed by extensive macroclimatic or global tropospheric processes, such as trade winds and monsoons, inter-tropical convergence, Hadley and Walker circulation, the El Niño (ENSO) phenomenon, polar fronts, tropical waves and storms, hurricanes and tropical cyclones. This group also includes dynamic processes with a local or focal influence related to the meso- and microclimate, such as tornadoes and waterspouts coastal, convective or orographic storms lightning storms. Some of these phenomena develop in the stratosphere (e.g., ozone layer).

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Table 2 Summarizes the effects that natural phenomena can have on the physical, biotic and perceptual environments.

Table 2

THE EFFECTS OF LARGE-SCALE NATURAL PHENOMENA ON PHYSICAL, BIOTIC AND PERCEPTUAL ENVIRONMENTS

Phenomenon	Effects		
	On the physical environment	On the biotic environment	On the perceptual environment
Volcanic eruptions	Air pollution from gas emissions; Changes to course of rivers, beach erosion and coastline alterations; Rubble and mud flows caused by snow and ice or by collapse of volcano walls; Contamination of water bodies; Fires; Earthquakes and tidal waves.	Ill effects on human health: From the energy released From environmental changes such as air pollution (discomfort in mucous membranes, eyes, skin, respiratory system) and water pollution; Loss of vegetation and wildlife due to fires, avalanches and acid rain; Loss of habitat; Extensive ecological imbalance.	Drastic changes to the landscape (barren, desolate landscapes and loss of agrological mosaic) with loss of aesthetic characteristics.
Earthquakes	Land and mudslides on mountains, cliffs and coastal bluffs due to effects of vibration; Large land movements on hillsides with high water table saturation; these can lead to damming and alter the course of waterways developments that can produce further avalanches; Elevation or subsidence from earthquakes; Environmental damage from effects on basic service infrastructure, such as water, electricity, gas, hydrocarbons (spills and fires or explosions of hydrocarbons and chemical products, etc.).	Ill effects on human health: From the energy released; From environmental changes such as air and water contamination from spills and fires; Damage to the vegetation cover of areas affected by landslides and avalanches.	Changes to the landscape due to landslide zones with loss of vegetation cover; More significant and even permanent changes can occur such as the appearance and disappearance of bodies of water.

Table 3

THE EFFECTS OF LARGE SCALE NATURAL PHENOMENA ON PHYSICAL, BIOTIC AND PERCEPTUAL ENVIRONMENT

Phenomenon	Effects		
	On the physical environment	On the biotic environment	On the perceptual environment
Tidal wave	<ul style="list-style-type: none"> I Flooding of coastal zones; I Intrusion of salt water in surface and subsurface bodies of water; I Water contamination due to chemical spills. 	<ul style="list-style-type: none"> I III effects on human health; I From the impact of the wave; I From environmental changes water contamination and salination; I Damages to coastal plant and wildlife from the impact of the wave and salt water flooding. 	<ul style="list-style-type: none"> I Significant affectation of the coastal landscape; I Possibly more significant and even permanent changes such as the appearance and disappearance of bodies of water.
Floods (of climatological, oceanic or other origin)	<ul style="list-style-type: none"> I Erosion, soil destabilization and landslides; I Sedimentation and washing of rubble and detritus into adjoining lands and bodies of water; I Possible damming and subsequent avalanches; I Contamination due to spills of water and sewage treatment tanks and the collapse of sewer and plumbing systems; I Contamination from chemical spills. 	<ul style="list-style-type: none"> I III effects on human health I From the energy released I From environmental changes such as water contamination; I Effects on plant and animal life from the energy released, physical changes and effects from chemical contamination; I Loss of vegetation cover; I Loss of habitat. 	<ul style="list-style-type: none"> I Washing downstream of sediment and obstruction of natural drainage systems can cause changes, possibly permanent, to the course of water bodies and alter the coastline.
Landmass shifts	<ul style="list-style-type: none"> I Erosion, soil destabilization and loss, and landslides and avalanches I Sedimentation and washing of rubble and detritus into adjoining lands and water bodies; I Possible damming and subsequent avalanches. 	<ul style="list-style-type: none"> I III effects on human health principally due to the energy released; I Landslides of forested land and destruction of vegetation cover; I Twisting and bending of trees (where reptation occurs). 	<ul style="list-style-type: none"> I Drastic changes to the landscape, mostly localized.
Hurricanes and cyclones	<ul style="list-style-type: none"> I Coastal erosion, changes to the granulometry of beaches and bathymetric changes brought on by tides and oceanic turbulence; I Changes to geographic characteristics; I Erosion, landslides and avalanches caused by rains; I Intrusion of salt water into surface and subsurface bodies of water. 	<ul style="list-style-type: none"> I Death and migration of animals; I Splitting and falling of trees due to winds; I Loss of coastal vegetation (mangroves), marine plant life and physical damage to coral reefs. 	<ul style="list-style-type: none"> I Drastic changes to the landscape due to loss of vegetation and alteration of the coastline; I See Floods.

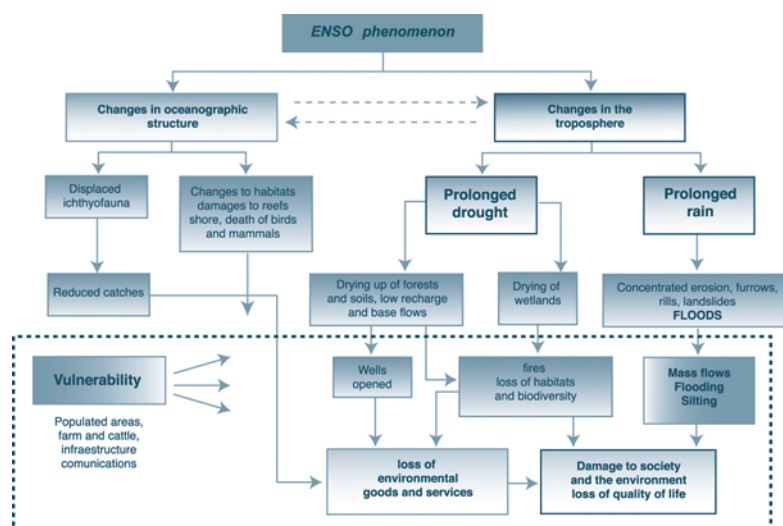
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Phenomenon	Effects		
	On the physical environment	On the biotic environment	On the perceptual environment
Drought	<ul style="list-style-type: none"> I Drying out and cracking of the soil; increase in the susceptibility of the soil to erosion and degradation; I Decrease in the surface water reserves subsurface water table, increase in the temperature of water bodies, loss of capacity to dilute contaminants; well salination may occur in coastal zones due to over exploitation; I Drying up of wetlands; 	<ul style="list-style-type: none"> I Loss of vegetation cover due to drying up of vegetation cover and associated forest fires; I Loss of biodiversity due to drying up of wetlands (often these are the habitat of species in danger of extinction and are part of the routes of migratory birds) and forest fires; I Other ecological imbalances (such as death of pollinating birds and insects); 	<ul style="list-style-type: none"> I Drastic changes to the landscape due to loss of vegetation;
ENOS Phenomenon	<ul style="list-style-type: none"> I See Floods and Droughts; 	<ul style="list-style-type: none"> I The appearance or increase in the incidence of some illnesses (malaria, dengue and others) is associated with the ENOS Phenomenon; I Changes in the oceanographic structure, disappearance of phytoplankton, displacement and death of ichthofauna, death of coral populations; I See Floods and Droughts; 	<ul style="list-style-type: none"> I See Floods and Droughts;

A figure with the causal linkages of the main impacts on the environment can be highly illustrative, as may be seen in the following two figures for the 1997-1998 ENSO phenomenon in Costa Rica⁴ and the floods and landslides in Venezuela⁵ in 1999. As with the description of the state of the environment before the disaster, inserts can be included as needed to deal with specific impacts. For example, in the assessment of the impact of Hurricane Mitch in Nicaragua, an insert was included on what happened at the Casita volcano;⁶ in the case of the disaster in Venezuela, an insert was included on the environmental problems caused in the Port of La Guaira when containers storing chemicals were washed away.

Figure 1

LINKAGE OF THE IMPACTS ON THE ENVIRONMENT CAUSED BY THE EL NIÑO PHENOMENON OF 1997 - 1998 IN COSTA RICA



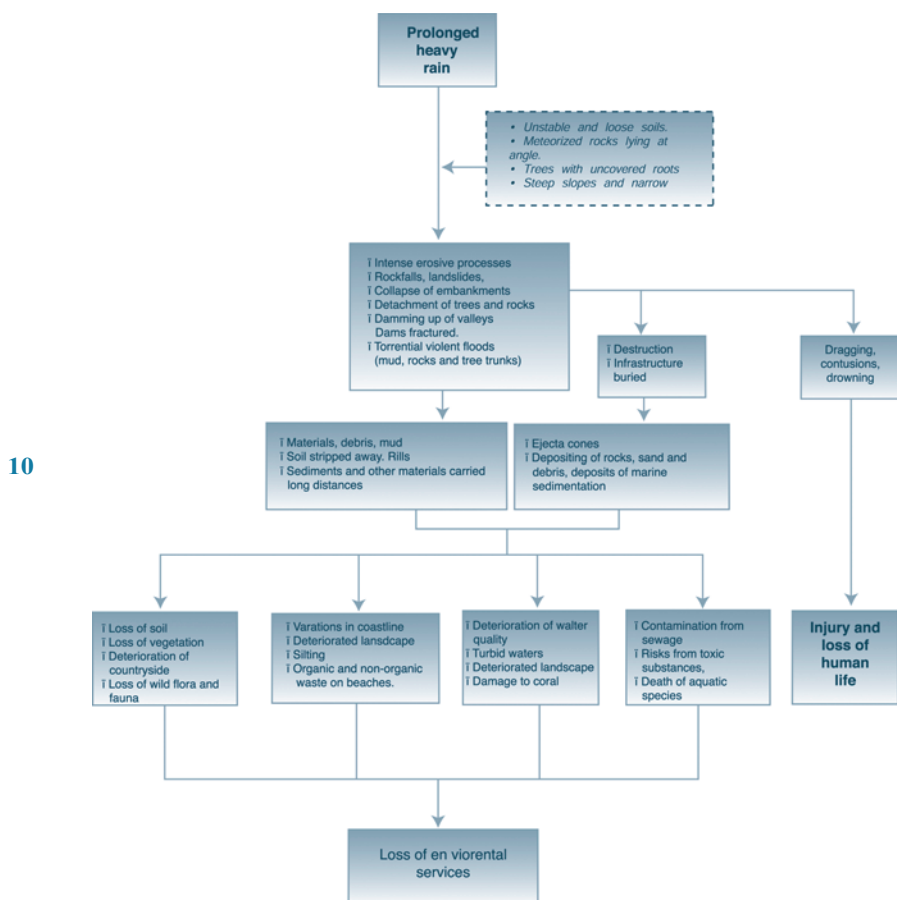
⁴ ECLAC, *Fenómeno de El Niño en Costa Rica durante 1997-1998: evaluación de su impacto y necesidades de rehabilitación, mitigación y prevención ante las alteraciones climáticas*, (LC/MEX/L.363), Mexico City, 1998.

⁵ ECLAC, *Los efectos socioeconómicos de las inundaciones y deslizamientos en Venezuela en 1999*, (LC/MEX/L.421/Add.1), Mexico City, 2000.

⁶ ECLAC, *Nicaragua: evaluación de los daños ocasionados por el huracán Mitch, 1998: sus implicaciones para el desarrollo económico y social y el medio ambiente*, (LC/MEX/L.372), Mexico City, 1999.

Figure 2

DETAILED STRUCTURE OF THE DISASTER GENERATED BY THE FLOODS AND
LANDSLIDES IN 1999 IN VENEZUELA



C. Qualitative environmental assessment

It is difficult to provide an absolute scale for an expert or professional to a relative quality value for environmental impact assessments. However, the task is made easier when there are exact figures for an environmental variable and parameters established by environmental control bodies. If environmental specialists base their assessments on their experience and on the appropriate literature, they will be able to make an adequate, logical and consistent estimate.

The quality, intensity and extent of the effects of a natural phenomenon on the environment will vary according to the force released, the sensitivity and quality of the medium receiving it, the medium's capacity for recovery, the time it takes to recover and the partial or total loss of environmental assets or services. Human activities bring with them some inevitable and irreversible environmental impacts, most obviously involving land usage. Whether for working, production, storage, access roads or service areas, such uses are all negative impacts known as loss of vital space. However, the natural environment's recovery in the short, medium and long terms will normally be brought about by its own systems of ecological evolution (natural succession, natural recovery, self-purification of water, assimilation and transformation of chemicals and pollutants in the biogeochemical cycles, the atmosphere's photochemical reactions, etc.). The aim in this case is to restore the environment's ability to absorb the effects of the natural phenomenon, particularly when it is of great intensity and duration.

Once the environmental status study has been carried out and the necessary analysis has been made (preferably with an interdisciplinary exchange of information) the environmental specialist(s) will finally be able to judge the general importance or class of the alteration in the overall system. One of the proposals for studying human developments is that an environmental impact study should use six negative and four positive assessments of the effects on any natural or anthropogenic system. These assessments are based on results that can be induced from observations, professional experience, environmental matrices or models employed and data generated by analyzing a project or by applying artificial actions to a given environment in space and time. This qualitative method can be used in the case of disasters caused by extreme natural phenomena.

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This assessment, which must be impartial, should preferably be made after completion of the study of the environment's features, of the environmental inventory and of such analyses as called for by the situation or by the institutional terms of reference. The classes of negative impact are given below and summarized in Table 3.

- a) Zero Impact. Insignificant or very slight, with swift environmental recovery or with minimal or very low prevention or recovery costs.
- b) Insignificant or Minimal Impact. Quantifiable impact that does not affect the system's stability. Recovery in the short or medium term; problems, alterations, changes and damage are insignificant when the benefits derived from the situation are taken into account.

- c) Moderate Impact. Change is marked, but restricted to a relatively limited area. Slight regional impact; short-term recovery; moderate or acceptable problems; simple and cheap mitigation.
- d) Severe Impact. Very marked regional or very extensive change. Recovery in the short or medium term if appropriate mitigation measures are implemented. A high level of discomfort and inconvenience, and mitigation is costly.
- e) Very Severe Impact. Very extensive, heavy and harmful consequences in the region. Possibility of partial or slight recovery at a very high cost in the medium and long term. Fewer options for using the resource in the future. In the case of developments, it signifies a permanent threat to resources, health or life.
- f) Total Impact. Even though only partially damaged, the system cannot recover; destruction is total. Loss of options for using the resource in the future. Where a human development is concerned, it will be imperative to forbid its installation or operation. In a disaster situation, natural recovery can take place in the very long term (more than 25 years).

Table 3

CLASSES OF ENVIRONMENTAL IMPACT

Environmental impact	Damage Quality	Extent of the Damage	Recovery Term	Recovery Costs
Zero	Almost non-existent	Very limited range	Immediate Very short	None
Insignificant or minimal	Slight	Local	Short	Low
Moderate	Marked	Local Limited range	Short or Medium	Medium to high
Severe	Very marked	Local or extensive	Medium or long	High or very high
Very severe	Serious and destructive	Local or extensive	Medium or long	Very high
Total	Total or almost total	Local or extensive	Very long or irreversible	Incalculable

Source: adapted from Alfonso Mata, 1995

One advantage of this method is that it becomes much easier to interpret the appraisal after inputting quantitative values, such as a hurricane's wind speed, an earthquake's magnitude, the extent of a forest fire, fish catch data or the extent of a flooded area.

Good examples of this idea are the Fujita Scale of Tornado Intensity and the Saffir-Simpson Hurricane Scale. The former classifies tornadoes as weak (F0), moderate (F1), significant (F2), severe (F3), devastating (F4) and incredible (F5). The latter similarly classifies hurricanes into categories 1 (moderate), 2 (strong), 3 (severe), 4 (very severe) and 5 (devastating). Scales have also been used to give a qualitative and quantitative idea of the El Niño phenomenon by classifying occurrences as moderate, strong, and very strong according to the average changes in the ocean's surface temperature. In the case of hurricanes, each category has different geographical zones of damage intensity, which are established using approximately the same qualitative standards. Accordingly, they can be classified into zones of moderate, strong, severe and very severe impacts.

We now provide examples of qualitative environmental assessments based on relating to the damage caused to the environment by Hurricane Georges in the Dominican Republic in 1998 and by the El Niño phenomenon in Costa Rica in 1997-1998.

Table 4 shows a breakdown by category of the areas affected by mass movements caused by Hurricane Georges in the Dominican Republic. The skill shown by the observers during field trips made to determine areas, type and depth of mass movements such as landslides, together with analysis of aerial photographs taken before and after the disaster, made it possible to estimate the percentage of the area affected and associate it with a qualitative description of the damage.

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Table 4

CLASSIFICATION ON THE AREAS AFFECTED BY LANDSLIDES AND AVALANCHES CAUSED BY HURRICANE GEORGES IN THE DOMINICAN REPUBLIC IN 1998.

Category	Affected area (%)	Estimated damage
D1	10	Slight
D2	30	Moderate
D3	50	Severe

Source: Adapted from Lücke, O. & R. Mora. 1998.

Table 5 shows the characteristics of the protected areas damaged as a result of Hurricane Georges and the impact classification defined by the authorities of the affected country.⁷

⁷ ECLAC, *República Dominicana: evaluación de los daños ocasionados por el huracán Georges, 1998: sus implicancias para el desarrollo del país*, (LC/MEX/L.365), Mexico City, 1998.

Table 5

CHARACTERISTICS OF THE PROTECTED AREAS IN THE DOMINICAN REPUBLIC
AFFECTED BY HURRICANE GEORGES IN 1998 AND THEIR CLASSIFICATIONS IN
TERMS OF RELATIVE IMPACT

National Parks and equivalent reserves ⁽¹⁾	Affected area km ²	Life zone ⁽²⁾ and special feature	Degree of environmental impact ⁽³⁾
NP Armando Bermúdez	766	S-wf and S-rf, the greatest altitudes in the Antilles	Moderate
NP Cuevas de Borbón or El Pourmier	0.25		Severe
NP Del Este	430	S-mf, S-df, Habitat of birds and plants, solenodon and hutia	Very Severe
Isla Catalina	22	S-rf	Very Severe
NP Isla Cabritos (Lake Enriquillo)	25	S-df endangered species	Minimal
NP Jos del Carmen Ramírez	764	S-wf and rS-rf, larger	Moderate
NP Laguna de Cabral or Rincón	240.54	Turtle and endemic fish	Severe (flooding)
NP Redonda and Limón Lagoons	107.7	S-rf	Moderate-severe
NP Los Haitises	1375	S-mf, endemic species	Severe-very severe
NP Mount La Humeadora	420	S-rf	Very Severe
NP Sierra de Bahoruco	800	LM-mf	Minimal
NP Sierra de Neyba	407	LM-mf	Moderate
Lomas de Barbacoa	22	LM-rf and LM-mf	Moderate-severe
NP Valle Nuevo	657	LM-rf and M, source of rivers Yuna and Nizao	Moderate-severe
RC Ébano Verde	23.1	LM-rf and LM-mt	Moderate-severe
SR Quinta Espuela	72.5	LM-mf	Moderate
UP Santo Domingo and Botanical Garden	16.4		Very Severe
Total	6,796		

Source: ECLAC, 1998

¹Abbreviations: NP: National Park; SR: Scientific Reserve; UP: Urban Park.

²Life zone (in the Holdridge sense, see Appendix XIII), Tasaico 1962.

Abbreviations: S: subtropical; M: montane; LM: lower montane; mf: moist forest; wf: wet forest; rf: rain forest; df: dry

³Areas affected by Hurricane Georges according to the National Planning Office of the Dominican Republic.

Table 6 shows another example of qualitative assessment, related to the El Niño phenomenon in Costa Rica in 1997-1998. This classification makes it possible to clearly define the values of the environmental services lost in the affected areas.

Table 6

MAIN ENVIRONMENT IMPACTS ON WILDLIFE PRODUCED BY THE EL NIÑO PHENOMENON IN THE HUETAR AND CHOROTEGA REGIONS OF COSTA RICA IN 1997 - 1998 a/

Impact on	Cause	Intensity	Recovery period	Notes
Wetlands CaOo Negro WLR	Drought	Severe	<5 years	Lower water level in lagoons and swamps
Wetlands CaOo Negro WLR	Fire	Very Severe	<1 year	Damage to undergrowth and surrounding grass
Cedar trees in CaOo Negro WLR	Fire	Irreversible, without spontaneous recovery	<20 years by importing species	The Maria cedar tree is unique to the Northern area. Once it has been burnt it will not recover
Riverside forests	Drought	Moderate	1 year	Late flowering, loss of fruits
Birds resident in CaOo Negro	Fire	Very Severe	<10 years	Loss of habitat
Migrant birds at CaOo Negro WLR	Fire	Very Severe	Unknown but could be swift	Loss of habitat
Land mammals	Fire	Very Severe	Unknown	Death of individual animals
Bats	Fire	Severe	Unknown	Loss of the habitat of a magnificent predator on insects and seed disperser
Batrachians Herpetofauna	Drying of wetlands	Moderate	Medium term	Reduce populations; smaller habitat
Threatened Ichthyofauna	Drying of wetlands	Severe	Variable	Tropical garfish (<i>Atractosteus tropicus</i>), a threatened living fossil.
Sea fishing	Oceanic imbalance	Severe	Variable	Fisheries displaced, greater effort. Coral reefs die
Trout breeding	Reduce currents	Moderate	Short term	Reduce flow of fresh water
Palm and undergrowth	Undergrowth burnt	Severe	Unknown	Disappearance of predators on pests

Source: ECLAC, 1998
Abbreviations: NP: National Park; WLR Wildlife Reserve

d) Classification and assessment of the effects on the environment

The next step is to classify the disaster's effects on the environment in terms of direct and indirect damage in order to make them compatible with the economic assessment methodology. Bear in mind that direct damage derives from changes in the quantity or quality of the environmental assets (environmental change): loss of soil and vegetation, loss of quality and/or quantity of water, changes in the dynamics of ecosystems and so forth. The disruption of human-made capital that prevents (or makes it more costly) the use of environmental assets is also considered direct damage: disruption of water-distribution networks or water-treatment facilities; disruption of communication networks and means of transport that make it impossible to carry out activities entailing the use of environmental goods and services; and so on. Indirect damage consists of modifications to the flows of environmental goods and services arising from a temporary inability to use the environmental resources due to the damage caused by the disaster up to restoration of natural and/or man-made capital.

Once the environmental impacts have been identified and classified into direct and indirect damage, the next step is to quantify and assess them. This is the most difficult stage of the assessment task, mainly because of time constraints, and the quality of the information is crucial.

The quantification process establishes the magnitude of the identified environmental effects: the area of burnt forest or of eroded soil, the length of beach damaged, the reduction in the volume of fishery catches, the reduced flow of water, the presence of pollutants in the water, the number of individual members of a species killed and so on. The assessment process puts an economic value on the identified environmental effects. In most cases, quantification comes before assessment, although quantification is not always necessary to assign a value to the environmental effect. In practice, different situations arise.

In many cases, neither quantification nor assessment can be carried out. For example there is rarely sufficient time available for disaster assessments to obtain quantitative information about the impact on specific species (without use value) or on other variables that form part of the ecosystems' dynamic. Also, it will only be possible to describe these impacts qualitatively, even if they can be identified and sustained. For example, in the case of fauna it is hardly ever possible to ascertain the number of affected individuals. Even if it were possible to obtain this information, it would be impossible to allocate a value to each of the affected individuals.⁸ Consequently, in such a case it would only be possible to identify the environmental effect. However, if a project to introduce new individuals were planned, its cost could be used as an approximation of the value of the individuals lost.

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The foregoing situation also occurs when there are changes to the landscape (variations to the coastline, for example) that have no significant effect on productive activities (for example, in the case of tourism). On other occasions, although it might be technically feasible, detailed information is not available or is of low quality. For example, it can be very difficult to determine the area of soil lost due to flood-generated erosion when the affected area is large and there are no remote sensors that might, be able to supply aerial photographs.

⁸ There are, for example, approximations of the existence value of endangered species, although they refer to the species as a whole and are not applicable to a specific number of individuals. The methodologies applied, as well as having been called into question, require a great amount of information.

e) Economic assessment of environmental damage

The purpose of assessing damage in this methodology is to identify the magnitude of the impact on the environmental resources and services and on the economy of the country or region affected.⁹ It eventually also allows one to propose strategies and plans to restore the environment after a disaster has occurred.¹⁰

As mentioned earlier, there are several distinct types of environmental values. Use values apply when goods and services that contribute to people's well-being are derived from the natural resources. Non-use values are not related to any direct or indirect use and arise from the psychological benefits derived from, among other things, the mere knowledge that the resource exists (existence value) or the wish to preserve natural capital for future generations to enjoy (inheritance value). Option values are defined as the benefits accruing from the preservation of options for the use of a particular resource when there is uncertainty about either its possible future use or its future availability.¹¹

There are different procedures for appraising natural assets.

- An estimate of the economic value of an environmental asset in the event that there is a market value for said goods. In this case, provided that prices are not distorted, the environmental changes can be appraised directly using market prices. If a natural resource provides several services and there is no market value for all of them, this procedure cannot be used to provide a reliable measure of the resource's economic value.
- An indirect estimate of the environmental goods for which there is no market by measuring the market prices of related economic goods (surrogate markets). The techniques used to make these estimates cannot be used to measure non-use values.
- An indirect estimate made after consulting users about the value that they ascribe to the environmental goods for which there is no market. This procedure can be used for both use and non-use values.

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⁹ One of the problems associated with environmental assessment is the calculation of the population that suffers loss of well-being, since some of the environmental services have the nature of a general public good (e.g. the maintenance of biodiversity and the fixation of greenhouse effect gases). This means, for example, that the damage caused when a forest fire releases carbon into the atmosphere affects the entire world as well as the country directly involved. The international community has created financial mechanisms such as the Global Environment Fund (GEF) to encourage countries to implement activities that generate global environmental benefits, although they do not directly benefit from them. The method used here is to include all damage regardless of the area involved (private, national, global).

¹⁰ It is normal in environmental analysis to make this kind of assessment by measuring (in monetary terms) the costs and benefits of the environmental changes so that they can be compared with other market values. Such a comparison makes it possible to make: prior assessments of alternative courses of action that involve both environmental changes and alterations in the allocation of other economic goods (cost-benefit analysis) and subsequent assessments of the impacts of real environmental changes on well-being in order to calculate the possible compensation for damage or to assess the economic efficiency of the restoration measures.

¹¹ Although some authors consider that the option value is a special variety of use value, others include it among non-use values.

Only a few environmental goods or assets can be measured directly in terms of their market value. Consequently, indirect procedures are commonly used to estimate them.¹²

Indirect procedures provide objective measurements of the damage brought about by different causes, and they allow one to identify and measure the physical relationships that describe the relationships of cause and effect. One such procedure is the production function method; others are based on different costs such as those of prevention, relocation, sickness, human capital and restoration. Because it is commonly used for these purposes, the restoration cost method is described in the following inserts.¹³

Restoration Cost Method

The economic benefits B_t derived from an environmental attribute EA (for example water of a given quality for human consumption) can be expressed as:

$$B_t = f(EA)$$

For the sake of simplicity, it is assumed that if $EA = 0$, then $B_t = 0$ (alternatively it can be considered that if $EA = 0$, the water can continue to be used, although at a higher cost since it will have to be treated in each home). If a disaster affects EA such that $EA = 0$, the economic damage should be measured indirectly from the present value of the lost benefits (PV). Alternatively, it can be assessed from the restoration cost C (investments required to return the water to its original quality). Assuming that the investment in restoration is “immediate”, restoration is economically efficient when $C \leq PV$, and for this reason an estimate that uses C will generally underestimate the economic damage. In principle, when $C > PV$, restoration should not be carried out; if it is, the economic damage will be overestimated.

Direct environmental damage is also produced when the damage to the man-made capital prevents, or increases the cost of, the use of environmental assets. This damage is mainly caused by the total or partial loss of other forms of capital, such as physical infrastructure.

The restoration cost to be considered is that of restoring the man-made capital, which is an indirect estimate of the environmental damage. As when making a direct estimate of damage, the economic benefits B_t derived from an environmental attribute EA (for example water of a given quality for human consumption) require a physical asset K (for example, the water distribution system).

$$B_t = f(EA, K)$$

¹² This classification is based on the work of Pearce and Turner (1990) and Turner et al. (1995).

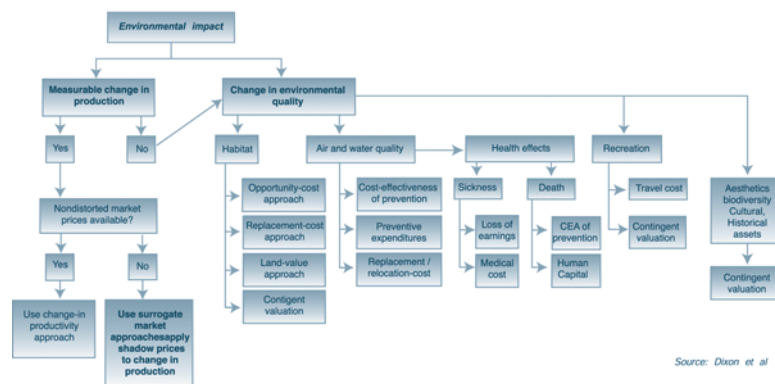
¹³ The restoration cost approach has been used often in the cost-benefit analysis of new projects and policies. In some countries, such as the United States, it is the basis for estimating damage compensation. The Integrated System of Economic and Environmental Accounting proposed by the United Nations considers this approach to be a possible method for environmental valuation. United Nations, *Integrated Environmental and Economic Accounting: An Operational Manual*, New York, 2000.

In this case, it is assumed that the disaster has not affected EA, and for simplicity it is assumed that if $K = 0$, then $B_t = 0$ (alternatively it can be considered that if $K = 0$, the water can continue to be used, although at a higher cost). If a disaster affects K such that $K = 0$, the economic damage should be measured from the present value of the lost benefits (PV). Alternatively, it can be assessed from the restoration cost C (investments required to rebuild the water distribution system). Assuming that the investment in restoration is “immediate”, restoration is economically efficient when $C \leq PV$, and for this reason an estimate that uses C will generally underestimate economic damage. In principle, when $C > PV$ restoration should not be carried out (if it is, the economic damage will be overestimated).

The other estimation methods can also be used, according to the basic information available.¹⁴ The graph in Figure 3 shows the procedures or methods that can be used to evaluate the different types of environmental change in different situations. Because of its importance in relation to the assessment of other economic sectors, the change-in- productivity approach (or the production - function method) is shown in a box.

¹⁴ For a more detailed explanation of these methods, see Dosi, D., *Environmental Values, Valuation Methods, and Natural Disaster Damage Assessment*, (LC/L.1552-P), ECLAC, Santiago, Chile, 2000.

Figure 5
ENVIRONMENTAL IMPACT VALUATION METHODS.



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Despite the use of restoration cost as a preference method, it is still necessary to assess the damage during the time taken to restore the asset. Also, there are situations in which this method cannot be used (because of the characteristics of the natural asset which has been affected, because it would not be economically efficient or because restoration is not going to be carried out). In such circumstances, when technically possible, one of the other existing methodologies will have to be used to assess the damage. The final choice of the assessment technique to be used will depend on a series of criteria and circumstances. Ultimately, the choice of technique is going to be influenced by the amount of information needed, its availability and the ability to obtain it at a reasonable cost within the time limit.

Most available techniques are inherently incapable of estimating all the value categories. For example, some of them focus on estimating a particular use value, such as the cost of travel for recreation values; hedonic prices for area environmental attribute values; or the prevention cost for values related to health risks.

Change - in - productivity approach

This approach seeks to exploit the relationship between environmental attributes and the output level of an economic activity. The underlying assumption is that when an environmental attribute enters a firm's production function, the economic impacts of environmental changes may be measured by looking at the effect on production and by valuing that effect at market (or shadow adjusted) output prices. The monetary estimates obtained in this way should not be interpreted as the "true" value measure, but as a proxy of the environmental change's ultimate welfare impacts. Under this approach, the value of natural capital is considered as resource inputs into production: land for agricultural production, forest as a source of timber, etc. If the natural resource of interest provides multiple goods and services, some of which are unmarketable, this valuation approach would fail to provide reliable measures of the resource's value. However, in the context of natural disaster damage assessment, this approach allows estimation of the environmental contribution to economic activities (agriculture, forestry, fishery) that are assessed separately.

If Y is the activity's output, ENV the environmental variable(s) of interest, and X_i ($i = 1, \dots, N$) other inputs, the production function might look like this:

$$Y = f(X_i, ENV)$$

A change in ENV (e.g., an increase or decrease in water pollution) will decrease/increase output levels. Broadly speaking, when Y is a marketed good, and the observable price is not affected by relevant market-failures, this price can be used to estimate the value of a change in ENV .

This approach is closely linked to the concept of economic rent. Economic rent is the return on a commodity in excess of the minimum required to bring forth its services. Rental value of the natural capital is therefore the difference between the market price and the cost of production/extraction. For example, in the case of agricultural and livestock production, the contribution of the environmental asset (agricultural and pasture land) can be estimated as the difference between the market value of the output and the production costs. In the case of forest resources, the value of roundwood production and other non-timber goods less production costs would represent the contribution of forests to economic activity. When an environmental change produces a diminution in the natural asset productivity, it can be assessed by multiplying the output change by the current output price.

This is the simplest way of using this valuation approach. Its main caveat is that it ignores possible price changes and this is not the case when significant and widespread changes in environmental conditions could entail non-negligible price effects. Market failures, such as open-access conditions (present in many fisheries, in which economic rent is close to zero) represent another problem for the use of this approach.

The time available and the cost make it practically impossible to make estimates based on contingent assessment methods (which are potentially capable of estimating both use and non-use values). Nevertheless, if such a study for any of the affected areas (species) existed before the disaster, then this method should be used to estimate damage.

The environmental value transfer procedure is the process by which a demand function or the value of an environmental attribute or of a group of such attributes obtained in one context is used to estimate environmental values in another context. The use of estimates from earlier studies to assess the costs and benefits of new projects, environmental regulations or other policies is common in the field of public decision-taking, and it has been formally recommended and adopted by several agencies for the economic assessment of environmental impacts.

The use of this technique is justified by the resources saved. The constraints of time and other resources that affect disaster assessments make this a particularly interesting method. Protocols exist for the implementation of this technique, which involves three major steps:

(1) Identification and selection of original studies

22 Once the analyst has identified the relevant ecological and economic cause-effect relationships which are believed to drive changes in people's welfare resulting from the environmental changes that are expected to occur or that have actually occurred at the study site (the "transfer context"), the analyst has to identify previous studies that can potentially quantify such changes.

Once a search of the literature or other available sources has revealed potential candidates for transfer, the analyst should evaluate their transferability and select the most appropriate one(s). Several criteria have been suggested for assessing the transferability of existing studies. Besides their scientific soundness, special attention should be paid to the original studies' relevance: that is the original study context and the transfer context should match as closely as possible. In particular, the magnitude of environmental changes and the affected "environmental commodities" must be similar; the baseline environmental conditions should be comparable; the affected populations' socio-economic characteristics should be similar.

(2) Synthesis of available information

Finding studies that adequately satisfy the aforementioned general criteria may prove difficult. If analysts are able to pick up several useful studies, however they face the problem of exploiting all the acquired relevant information in an efficient and sensible way.

The simplest approach consists of using the bundle of selected studies to get a range of possible estimates (lower bound and upper bound estimates) or simple descriptive statistics (e.g., the mean and standard error).¹⁵ More sophisticated approaches exist, such as meta-analysis techniques.

(3) Transferring information

After identifying relevant studies and synthesizing available information in some way, the next step consists of transferring such information, in order to get cost (or benefit) estimates. This can require ad hoc adjustments to the available estimates and may entail some arbitrary decisions.

The Discount Rate

Bearing in mind that natural resources are considered to be economic assets whose values can be indirectly estimated from service flows, an assessment of environmental damage should account for the variations in these flows during the period in which they occur. To do this, it is necessary to identify the times that the loss of environmental services begins and ends, to estimate annual losses of well-being and to choose discount rate.

The use of discount rates is the subject of wide-ranging, and as yet unsettled, theoretical debate. In principle, the difficulty of choosing an appropriate discount rate can be avoided if a political decision has been taken to restore the natural capital's productivity, provided that the restoration is technically possible and is in fact carried out. However, this will only be the case when restoration is carried out immediately after the disaster and the recovery of the natural capital's productivity is also "immediate".¹⁶ In reality, if restoration is not carried out immediately or if its execution will take more than one year, a discount rate should be used to express the cost of restoration at present values so as not to overestimate the damage. The same thing happens when the restoration is immediate but does not enable total immediate recovery of the environmental services. The three alternative scenarios shown below will make this clear.

1. The restoration (whose total cost is C) is carried out immediately ($t = 0$), but the capital will be recovered over time $t = n$. During this time, the people affected suffer annual losses of well-being B_t ($t = 0, \dots, n$). In this case, the economic damage caused by the disaster will be

$$D = C + \sum_{t=0}^n \frac{B_t}{(1+r)^t} \quad (1)$$

2. The restoration is executed in time $t = n$ and, once completed, enables the immediate restoration of productivity. In this case,

¹⁵ For example, in a study aimed at assessing the total economic value of Amazonian deforestation, Torras (2000) exploits previous studies which have focused on specific forest value categories (direct use, indirect use, and non-use values), and calculates the annual per-hectare economic loss by using the mean of the estimates from these studies. In this way the author arrives at an estimated total annual value of a representative hectare of Amazon rain forest of US\$1 175 (1993 prices). Although the methodology employed is quite crude, the paper provides valuable information about a large number of empirical studies in developed and developing countries aimed at estimating forest values.

¹⁶ Although this situation is unlikely to be found in reality, there are similar situations, such as when restoration consists of cleaning debris from a beach used for recreation.

$$D = \frac{C}{(1+r)^n} + \sum_{t=0}^n \frac{B_t}{(1+r)^t} \quad (2)$$

3. Finally, the restoration is carried out in time $t = n$, but recovery of the asset's productivity will take $t = n+s$. In this case,

$$D = \frac{C}{(1+r)^n} + \sum_{t=0}^{n+s} \frac{B_t}{(1+r)^t} \quad (3)$$

Most of the conceptual problems related to the discount process –intergenerational equity, uncertainty about future preferences and uncertainty about the discount rate itself– can be avoided if the recovery phase is not “too long”.¹⁷ In this case (short - term environmental damage), the personnel in charge of the disaster assessment should use a “standard” discount rate, such as (for example) that used for cost-benefit analysis of public projects.

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Other approaches can also be used. For example, Kunte, A., et al (1998) used a discount rate of 4% for estimating the value of natural capital as resource inputs into production of the countries of the world. Kunte, A., K. Hamilton, J. Dixon and M. Clemens. *Estimating National Wealth: Methodology and Results; Series Indicators and Environmental Valuation of the World Bank* (paper circulated to encourage thought and discussion), Washington, 1998.

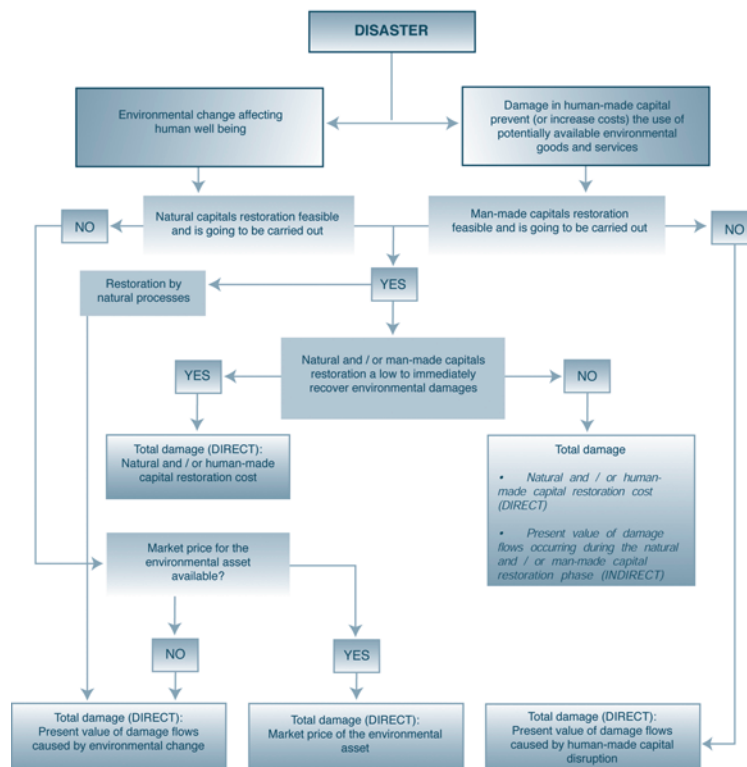
3. Estimating the environmental damage

When making preferential use of the restoration cost method to assess damage, the environmental specialist should remember that there are differences between the restoration of a natural asset and the restoration of man-made capital.

First of all, it may not be technically possible to restore the natural asset. Second, when it is possible, it may take more time to restore the natural capital than the man-made capital infrastructure. Third, unlike man-made capital, natural capital is sometimes restored by natural processes, provided human intervention allows. This is the case, for example, of some types of forest after a fire or of the sandy beaches on some islands following the erosion caused by hurricanes or tropical storms. In this last case, there is no point in making an assessment by applying the restoration cost, and other methods will have to be used. The following graph illustrates the procedure for making an economic assessment of environmental damage.

¹⁷ The longer the restoration stage, the more difficult it is to identify a suitable discount rate. Therefore, the Principle of Caution advises a downward adjustment of the “standard” discount rate. However, it is not easy to say how much the rate should be reduced.

PROCEDURE OF ECONOMIC ASSESSMENT OF ENVIRONMENTAL DAMAGE



The definitions of direct and indirect damage, the direct and indirect ways of estimating damage and the calculation methods described previously should be borne in mind when studying the following specific examples of damage caused to different environmental assets and services.

a) Damage to the air

The air is often affected by the pollution caused by natural events, such as volcanic eruptions, as well as that caused by human activities. It is clearly not feasible at present to ascribe a value to pure air for human consumption. Any definitive alteration in air quality can only be estimated indirectly by calculating the cost of air cleaning programmes that might be undertaken (restoration cost). These are not normally put into effect to counteract natural disasters, but are used in the case of urban environmental degradation caused by human activities. In this sort of case, the assessment will be based on the annualized investments required to implement the clean-air projects.

The indirect damage resulting from temporary air pollution can be measured according to the corresponding increase in economic flows (higher current expenses) required for health and defensive expenditures throughout the period needed to re-establish normality.

26 A theoretical example of this situation would be a volcanic eruption that pollutes the air in a city and reduces visibility for interurban transport in the zone of influence. The air would only be cleaned naturally with the passing of time (probably by the action of rain), so it is not feasible to assess direct damage. However, it is possible to determine the resulting indirect losses during a three-month period, which is the time required for the situation to return to normal, by measuring the higher costs of medical care for the population, the cost to the population of buying masks (to avoid respiratory problems) and the increased costs derived from the use of longer, more expensive routes to carry people and goods (because of transportation difficulties). The tourism sector might also be affected by a lower flow of visitors. These types of indirect damage will, however, have been assessed under the health, transportation and tourism sectors.

b) Damage to water resources

There are two types of damage that can occur: changes in the quantity and quality of the water (natural asset) and damage or destruction of water works and distribution systems (man-made capital).

The assessment of direct damage is different in each case. In the first case (reduction in the quality or quantity of water), it is usually difficult to ascribe a value to the damage caused to the asset. Nevertheless, an assessment can be made indirectly based on the annualized investments needed to construct water purification/cleansing works or systems. In the second case (damage to man-made capital), the direct damage can be estimated through the cost of rehabilitating or reconstructing the existing systems, whether these supply water for human or industrial consumption, electricity generation or agricultural irrigation.

Calculations of indirect damage in the case of pollution are based on the higher operating costs and lower income of the existing treatment plants, as well as on the defensive expenditure incurred by private individuals (e.g., the purchase of filters) and on the increased cost of providing the population with medical care. If water works or distribution systems have been affected, the indirect damage is also assessed according to the higher costs and lower income of the companies providing the service.

An example of this is damage caused by increased silting in rivers due to heavy rains in a catchment area where water is collected for human and industrial consumption. Assessable direct damage is the cost to the water treatment plant of repairing the works in the catchment area and cleaning its equipment. Investments in forestation to protect the catchment area can also be included under this heading. Indirect damage, on the other hand, includes the increased cost of operating the plant because more energy is needed to pump water from further away, as well as the fall in income due to reduced billing during the time needed for its restoration, when the plant is either unable to operate or capable of only limited operation.

In the case of floods that damage agricultural irrigation systems, the direct damage would be equal to the cost of restoring or replacing the irrigation systems, while the indirect damage would be equal to the present value of the difference between the market value of production and the production costs during the time that the repairs or reconstruction are being carried out.

When there is drought or insufficient water to meet needs, direct damage is not assessed. However, the production that will not be obtainable during the drought in the agricultural and livestock, industrial and commercial sectors (including services), as well as the increased costs and reduced income experienced by the providers of services such as electricity and drinking water, is assessed as indirect damage.¹⁸ As in the case of air pollution, much of this damage will already have been assessed in the infrastructure, health and agricultural sectors.

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c) Damage to the land and seabed

The land can be permanently or temporarily affected by the action of a natural or anthropic event. In some cases, the impact may be positive, as when deposited materials have the medium-term effect of making the soil more fertile or when unexpected rains make production possible in areas that are normally arid.¹⁹

In the case of a negative impacts, direct damage can be assessed directly by taking the market value of the affected land, provided that this is not economically distorted. Alternatively, it can be assessed by calculating the present value of the farm production less the production costs (economic rent) that would no longer be obtained. In the case of repairable damage, the direct damage can be assessed as the cost of restoring the affected area through, for example, soil conservation projects. In the case of irrigated land its value implicitly incorporates the value of water.

¹⁸ See, for example, the case of the losses caused in Central America by the drought of 2001, in ECLAC, L.510/Rev.1, february 12, 2002.

¹⁹ This would be the case of the soil that received deposits of ash with a high mineral content from the Chinchón volcano in Mexico and, as a result, became more productive. A similar situation occurs with extensive areas of normally dry land in Ecuador that become productive temporarily because of the action of unexpected rains caused by the El Niño phenomenon.

In the case of land used for housing and human settlements, the assessment of the direct damage to the natural asset is based directly on the land's commercial value (in fact, urban land fits better in the concept of constructed capital). The assessment of the damage caused to the man-made capital (infrastructure and services) is based on the restoration or replacement value. These assessments are normally included in the housing and human settlement sectors.

During a natural disaster such as a hurricane, the waves that are generated by the intense winds will often have a significant impact on the seabed and marine ecosystems. The waves interact with the seabed and can cause considerable reshaping, which extends to the shoreline. The impact may be positive, as in the case of sand brought to the shoreline from offshore reserve areas, a process known as cross-shore sediment transport.

In the case of beaches, pieces of land or buildings for recreation or tourism that have been flooded, silted up or covered by debris deposits, the assessment of direct damage will be based on the cost of clean-up and the cost of beach restoration (including sand refill) when such measures are economically feasible. This damage assessment may have been made in the tourism sector.

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Where soil rehabilitation is technically and economically feasible, the assessment of indirect damage should be based on the present value of the difference between the market value of the output crops and crop production costs during the period required for the rehabilitation. If a natural event makes production feasible in areas that are normally arid, the new production should be deducted from the losses to determine the event's net effect. This assessment is normally made in the agricultural sector. Given that farm production is the first link in a chain, it is also necessary to estimate the fall (or rise) in industrial production and in the commercial sector's sales resulting from the fall (or rise) in farm production.

Disaster-induced indirect damage related to the housing and human settlements sector is normally assessed under that sector. Indirect damage to tourism should be assessed as the income that will not be received during the time that the beaches are being rehabilitated. This figure forms part of the damage assessment of the tourism sector.²⁰

d) Damage to biodiversity

Some disasters have extremely negative impacts on forests and vegetation. Fires, droughts, hurricanes and heavy rains are capable of causing permanent or temporary damage to large areas of forests and mangrove swamps.

²⁰ Likewise, tourism sector income that cannot be generated because of direct damage to roads and other means of communication (although tourism installations have not been damaged) should also be considered as indirect damage.

The assessment of the direct damage in such cases can be based on the commercial value of wood and non-timber products in natural forests or plantations that are in production less the production, costs (economic rent). In the case of natural woodlands not being exploited for their timber,²¹ the direct damage can be assessed indirectly by calculating the value of the environmental services (such as sequestration and storage of carbon, conservation of biodiversity and regulation of the water cycle) and goods (such as firewood and non-timber products when these are exploited) that will be unobtainable for a long period (the length of the period should be defined by the environmental specialist).²² Mangrove forests provide environmental goods and services such as timber, fisheries and other species habitat, maintenance of estuarine water quality and shoreline protection. If actions are planned for the recovery of forests, mangroves swamps or urban parks, the assessment of direct damage is based on the restoration cost.

An example of this is provided by the Costa Rican forests that were damaged by fire during the drought caused by El Niño in 1997-98. Since they were expected to recover naturally, direct damage was assessed based on the present value of the forest services that would not be obtainable during the recovery period.²³

When forests and mangrove swamps are only partially or temporarily affected, the assessment of indirect damage should be based on the present value of the environmental services that will be unobtainable during the period needed for the assets to recover. If the assets are totally lost with no possibility for recovery or if restoration is deemed a very long-term proposition, indirect damage should not be assessed.

29

It is not normally feasible to make an assessment of direct damage in the case of wild animal species, whose loss reduces biodiversity.²⁴ However, where repopulation is planned, the cost can be used as an indirect way of assessing the damage. A similar situation occurs with loss or direct damage caused to the coral formations that are mainly found on Caribbean coasts. Hurricane waves can damage coral reefs, as the horizontal and vertical action of the waves can break off pieces of coral. After such an event, and in cases where coral damage has been reported, it may be necessary to carry out an underwater video reconnaissance, or to rely on local dive professionals to estimate the aerial extent of damage.

²¹ In the case of protected areas, another way of valuing damage in natural forests not used for timber extraction is through the opportunity cost of preservation (the foregone benefits from converting them to pasture or agricultural land). This value must be considered as the minimum value of the protected area.

²² Some countries have mechanisms for payments of environmental services that permit a direct approximation of the value (partial or total) of services associated with forests.

²³ ECLAC, 1998, *The El Niño phenomenon in Costa Rica in 1997-1998: Assessment of its impact, and rehabilitation, mitigation and prevention needs in light of climatic change*, (LC/MEX/L.363), Mexico City

²⁴ In very special cases, direct damage to certain wild species could be estimated when there is a market for products or hunting licenses (sport or traditional). However, while a commercial value could be assigned to a specimen of the species (a partial approximation to its total economic value), estimating the affected population is more problematic.

In this case, it would also be possible to make the assessment indirectly on the basis of the environmental services (coastal protection recreation, fishing, biodiversity conservation) provided by the coral reefs as ecosystems.²⁵ The main difficulty with this method lies in estimating the chances of natural recovery and the length of time that it will take.

As the waves travel over the reefs to shore, they often uproot seaweed beds. An example of this was recorded in Belize in the Inner Passage between the mainland and the cayes, after Hurricane Keith. That event uprooted hundreds of hectares of seaweed beds, which were seen floating on the surface of the sea in large mats. Assessment of the value of this ecosystem can be linked to the cost of seaweed replanting programmes, evaluated on a per hectare basis; another option is the estimation of the sand producing potential of the seaweed beds and the subsequent valuation of the beach enhancing potential of this sediment.

Where damage is caused to the coral formations and emblematic species that attract tourists, it is possible to base an assessment of indirect damage on the income that will not be obtainable by the tourism sector during the time that it will take to recover the former environmental conditions.²⁶ However, this can only be done when the activities are identifiable in economic terms (e.g., lower takings from entry fees to land and marine parks; less income for recreational diving businesses).

30 e) Environmental damage by man-made capital disruption and overlap with other sectors

As indicated above, environmental damage can arise from man-made capital disruption (disruption of water distribution networks and roads, loss of buildings such as hotels, etc.) that prevents the use of environmental goods and services. Restoration cost of man-made capital is the way to estimate this direct environmental damage. Under this approach, it is necessary to distinguish two situations:

- (1) When man-made capital is closely and exclusively linked to the use of environmental goods and services, man-made capital restoration cost can be considered as a proxy for environmental damage. This is the case of water distribution networks that allow the use of water or roads that are only used for recreation in natural areas (for example, inside a national park).

²⁵ Reviewing work done in assessing reef value in Australia, Aruba and Jamaica may assist in assigning a monetary value to the damaged reef. Valuation rates can vary from US\$7 500 per hectare to US\$500 000 per hectare, depending on the location of the reef and its role in the overall ecosystem. Recent work on coral reef valuation includes the importance of coral to the pharmaceutical industry. Restoration actions (such as coral transplantation) are sometimes carried out.

²⁶ A concrete example of this is the case of the Caribbean island of Anguilla, whose coral formations and beaches have often been swept by the wave of hurricanes and tropical storms in recent years, negatively affecting tourism occupancy rates after such events. See ECLAC, 1995, *The macro-economic effects and reconstruction requirements following hurricane Luis in the Island of Anguilla*, (LC/MEX/L.289 and LC/CAR/L.462), Mexico City.

- (2) In many cases, however, man-made restoration cost also encompasses the use of non-environmental goods and services such as infrastructure (e.g., roads) used for trade or human transportation, but not exclusively linked to recreation. Hotels in nature areas allow for both nature-based recreation and other goods and services (food, lodging, fun, etc.). In these situations, human restoration costs include the present value of both environmental goods and services, and non-environmental goods and services. Consequently, this approach can overestimate environmental damage.

Something similar happens when estimating indirect damage, for example when environmental damage temporarily prevents tourist activities. In this case, only part of the tourist expenses can be considered exclusively “environmental” and it is not always easy to segregate this component. One instance in which it is possible to determine a specifically environmental component is via entry fees charged to enter protected areas or taxes used for environmental protection; these can be used as a proxy for the environmental contribution to the economic activity. However, a deeper exploration of such damage could be very difficult.²⁷

Thus, in both cases (direct and indirect environmental damage), it may be difficult to isolate an accurate figure for environmental damage distinct from that of other sectors. This will depend on the available information. This problem is partially overcome (in terms of taking into account all environmental damage) when considering that most environmental damage is already considered in the assessment of other sectors (agriculture, tourism, infrastructure, health, etc.).

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To summarize, the following figure shows the different situations in which environmental damage assessment can be divided.

²⁷ The approach for estimating the economic rent generated by the environment in tourist activities is through the difference between the market price (for example, room rate per night) and the hotel production costs (salaries, inputs and other expenses, including a normal rate of return of the investment). Hotels located in places with special landscapes can charge higher prices than others with less favored locations. The same occurs within a hotel; rooms with the best views are more expensive.

Table 7

DIFFERENT TYPES OF ENVIRONMENTAL DAMAGE ASSESSMENT

Direct and indirect environmental damage	
I	Without monetary valuation. Damage described or qualitatively assessed.
II	Monetary valuation. Environmental damages not included in the assessment of other sectors.
III	Monetary valuation. Environmental damages included in the assessment of others sectors. They can be easily isolated from other sectors.
IV	Monetary valuation. Environmental damages included in the assessment of other sectors. It is difficult, if not impossible, to isolate them from other sectors.

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Monetary assessment of environmental damage is limited to the situations described in boxes II and III in the figure. The amounts obtained in box II will be added to the estimations of other sectors to get an overall assessment of direct and indirect damages. The sum of boxes II and III, will provide a clearer idea of the damage suffered by the environment and facilitate a comparison with other sectors. However, when arriving at overall figures of damage, the amounts of box III must be separated to avoid double counting.

The following table shows the types of environmental damage classified according to the different categories described above and the sectors in which they are most likely to have been included.

Table 8

TYPES OF ENVIRONMENTAL DAMAGES AND OVERLAP WITH OTHER SECTORS

<i>Direct and indirect environmental damage</i>	
I Without monetary valuation. Damage described or qualitatively assessed.	
II Monetary valuation. Environmental damages usually not included in the assessment of others sectors. (i) Environmental damage usually that is assessed on the basis of the cost of environmental restoration, especially when the conservation of the affected environmental asset is the responsibility of the country's environmental bodies. This is usually the case with protected natural areas and (ii) environmental damage that is assessed by variations in the flows of goods and services for which there are no clearly established markets (e. g., environmental services provided by forest; such as the sequestration of atmospheric carbon or regulation of the water cycle). The most common damages included in this category are: ┆ Loss of environmental services linked to the damage of ecosystems such as forest, mangroves, coral reefs, etc. ┆ Damage to the infrastructure of protected areas (roads, signposts, research centers, etc).	
II - III Monetary valuation. Damages in which the frontier between environment and other sectors assessments is not very clear. It could depend on the organization of the assessment team or on the institutional organization of the country affected. ┆ Damage to infrastructure and equipment related to environmental sanitation, such as dumps and garbage collection and treatment facilities and equipment ┆ Restoration of urban parks ┆ Lower earnings from protected areas (terrestrial or marine parks) entry fees ┆ A fall in taxes used for environmental protection (e. g., additional airport or hotel taxes that are levied on foreign visitors in certain countries)	Sectors in which environmental damage could have been assessed
	Water and sanitation sector and/or housing and human settlements
	Tourism
	Sectors in which environmental damage have been
	Agriculture and Fishing sectors
	Health, drinking water and sewage sectors
	Tourism
III - IV Monetary valuation. Environmental damages usually included in the assessment of other sectors. Isolating environmental damage depends on the availability of information. ┆ Loss or loss of quality of agricultural and pasture land ┆ Loss of agricultural and forestry production ┆ Loss of fish catch ┆ Water distribution problems caused by contamination, disruption of distribution in infrastructure and/or availability ┆ Health problems linked to changes in environmental conditions ┆ Losses related to the tourism sector ┆ Changes in energy production and distribution caused by environmental changes (e. g., silting of dams or disruption of distribution networks) ┆ Loss of sub-soil assets (e. g., oil spill) ┆ Relocation of houses exposed to new threats ┆ Diminution of house values caused by environmental changes (including changes in landscape) ┆ Problem in transport (terrestrial, maritime and fluvial) caused by landslides, floods, silting of ports and rivers, etc. ┆ Changes in environmental conditions that demand restoration actions (e. g., water courses divert demanding to undertake drainage actions).	Energy sector
	Housing and human settlements
	Infrastructure: communication and transport sector

When the summary is prepared, the global specialist or analyst must ensure that there has been no double counting, so that all comparisons made later (for example, with the GDP of the affected country or region) will be valid and give a true picture of what really happened because of the disaster.

APPENDIX XII

EXAMPLES OF ENVIRONMENTAL DAMAGE CALCULATIONS

Example 1: Environmental damage caused by a hurricane

The wind, waves, and rain produced by a hurricane have affected an area of a country noted for the wealth of its environmental heritage. The main economic activities of the affected area are fishing and the tourism attracted by its beaches and diving around its coral reefs. The following table presents the identified changes to the environment and the human-made capital that affect the people's well-being.

Table 1

IDENTIFICATION OF CHANGES IN THE ENVIRONMENT AND MAN-MADE CAPITAL AND THE ENVIRONMENTAL GOODS AND SERVICES INVOLVED

Identified environmental changes	Environmental goods and services involved
• Deaths of seabirds and destruction of their habitat (nesting and breeding places)	• Wildlife habitat • Recreation (tourism)
• Changes in the quality of the sea water: turbidity, floating sea-grass, faecal contamination from flooded septic tanks	• Navigation • Fishing • Recreation (tourism)
• Changes to the shoreline: erosion, silt barriers, loss of beaches and beaches littered with debris	• Land (property) • Recreation (tourism)
• Damage to sea-grass beds: mechanical damage, excess siltation, smothering and loss of fishing habitats	• Fishing • Wildlife habitat
• Mangrove swamps: defoliation and uprooting of plants least tolerant species exposed to saltwater flooding	• Coastal protection • Wildlife habitat • Fishing
• Coral reefs: Localized mechanical damage and other impacts (asphyxia and growth of algae)	• Coastal protection • Recreation (tourism) • Fishing • Unique ecosystem (existence value)
• Changes in the sanitation conditions caused by flooding and overflowing of septic tanks and sewer lagoons	• Health conditions • Recreation (tourism)
Infrastructure and equipment affected	
• Tourism and fishing infrastructure: Hotels, piers, boats, fishing gear and seawalls	• Recreation (tourism) • Navigation • Fishing
• Destruction of septic lagoons and tanks	• Health conditions • Recreation (tourism)

Direct damage to environmental assets is measured on the basis of their market value (when there is one) or of the investments in restoration planned by the government and other participants in the affected country. The indirect damage includes the loss of income during the time that the infrastructure and natural capital are being restored (when their recovery is not instantaneous). As will be seen, part of the damage has already been included in the assessments of other sectors (fishing, tourism and infrastructure). The calculations of direct and indirect damage are shown below with a chart explaining the assessment process.

Table 2

ASSESSMENT OF ENVIRONMENTAL DAMAGE

A. ENVIRONMENTAL DAMAGE NOT ASSESSED IN OTHER SECTORS	
A.1 DIRECT ENVIRONMENTAL DAMAGE	US \$000
1. Properties lost due erosion of the coast (including beaches) <i>Measured at places where there is a market for plots of land. The lost area measures 6,400 m² at a price of USD 200/m². Damage is considered to be irreversible or very long-term.</i>	1,280
2. Clean-up of beaches for tourism purposes <i>in tourism areas, investment made shortly after the hurricane by the municipal authority (financed by the hotel keepers) to clean up the debris and rests of vegetation. The total cost of USD \$ 280,000.</i>	280
3. Damage to the mangrove swamps (partial assessment) <i>The priority for the environmental authorities is the recovery of the belt of mangrove swamps that offer greatest protection against the effects of storms . It is estimated that an area of 2,300 hectares of mangrove swamps was damaged. A replanting programme is projected for the 500 hectares situated in the most vulnerable places whose natural recovery is thought difficult. The cost of replanting is USD \$ 4,800 per hectare. The environmental value of the rest of the damaged mangrove swamps is not assessed.</i>	2,400
4. Damage to the coral reef <i>A study of a similar ecosystem in a Caribbean island to appraise the coral reef in the area takes the following environmental services into account: recreation (linked to tourism); fish habitat; coastal protection; maintenance of biodiversity; source of sand for beaches and dunes. The study calculates that the present value of a hectare of coral is between USD \$ 90,000 and USD \$ 320,000. No option value or existence values are calculated. According to the environmental authority, an area 7,000 m long and 75m wide has been seriously affected, with irreversible damage or very long-term recovery. The value used (simple average) is USD \$ 205,000 per hectare.</i>	10,762
5. Direct damage not assessed <i>The following direct damage has been identified but not assessed since no restoration measures are planned and there is no information that would make it possible to use another assessment methodology.</i> <ul style="list-style-type: none"> • Destruction of avian habitats; • Changes in the quality of the seawater (turbidity, floating seaweed); linked with the fishing, tourism, and transportation sectors; 	
TOTAL DIRECT DAMAGE	14,722
A-2 INDIRECT ENVIRONMENTAL DAMAGE	
6. Indirect damage not assessed <i>This consists of the environmental services lost during the recovery period of the mangrove</i>	
TOTAL INDIRECT ENVIRONMENTAL DAMAGE	0
A. TOTAL ENVIRONMENTAL DAMAGE	14,722

Table 3
ASSESSED IN OTHER SECTORS, WITH ISOLATION OF COSTS

B. ENVIRONMENTAL DAMAGE ASSESSED IN OTHER SECTORS	
B.1 DIRECT ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	
7. Restoration of the following infrastructure and equipment: • Fishing sector (information obtained from the person responsible for the sector). Includes i) equipment and fishing vessels; ii) cold storage facilities; iii) stored fish and seafood	4,780
• Drinking water and sanitation (information obtained from the person in charge of infrastructure). Includes damage to the drinking water and drainage systems (pumping stations, storage tanks, septic pits, etc)	1,655
TOTAL DIRECT DAMAGE	6,435
B.2 INDIRECT ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	
8. Changes in environmental goods and services flows during the restoration period of the human-made capital and natural capital: • Tourism sector (information obtained from the person in charge of the sector). Includes the fall in income due to lower takings from visitors: i) entry fees to marine parks (for diving); ii) lost airport departure taxes used for environmental protection	935
• Fishing sector (information obtained from the person in charge of the sector). Assessment of the reduction in the catches until they return to normal levels, i.e. the recovery of fishing vessels and equipment and normal sea conditions. Value of lost catches estimated at US\$ 4.6 million; costs of production are 75% of revenues.	1,150
• Drinking water and sanitation (information obtained from the person in charge of the sector). Includes additional costs for carrying water, chemical treatment, energy consumed by emergency equipment, and prevention campaigns, and lower billing because less water is provided	1,138
TOTAL INDIRECT DAMAGE	3,223
TOTAL ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	9,658

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Table 4
ASSESSED IN OTHER SECTORS, WITH NO POSSIBILITY FOR ISOLATION OF COSTS

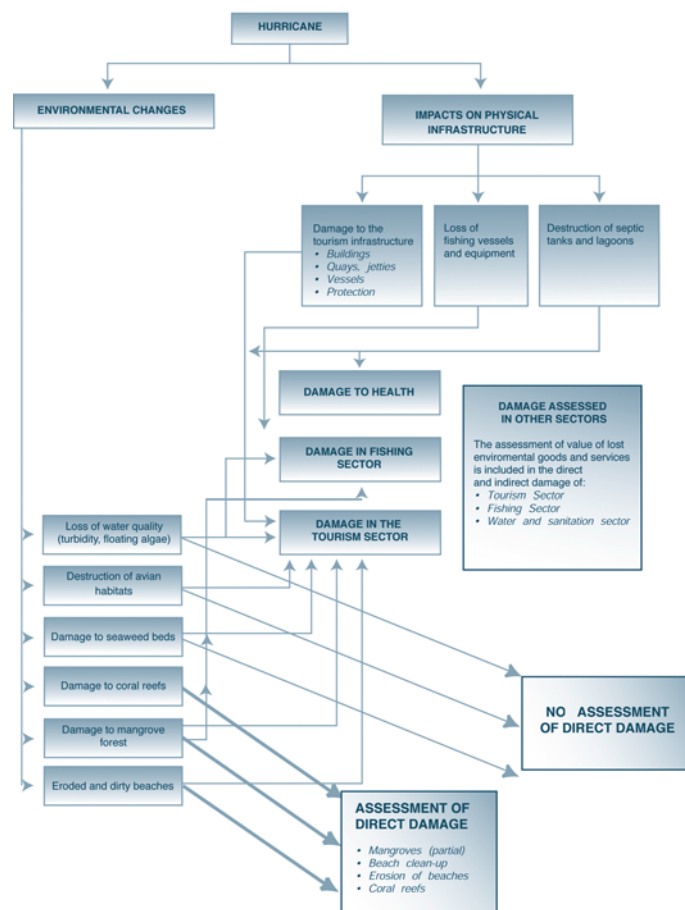
C. ENVIRONMENTAL DAMAGE ASSESSED IN OTHER SECTORS	
C.1 DIRECT ENVIRONMENTAL DAMAGE THAT CANNOT BE ISOLATED FROM OTHER SECTOR	
9. Restoration of the following infrastructure and equipment: • Tourism sector (information obtained from the assessment team responsible for tourism). Includes the cost of replacing i) hotels (building, furniture, equipment, facilities, including a golf courses); ii) gift shops; iii) restaurants; iv) quays and tourist craft; v) sea-walls. Restoration costs add up US\$ 62 million. Part of this figure corresponds to the value of the lost environmental services related to the tourism, but it is not easy to estimate it.	N/A
C.2 INDIRECT ENVIRONMENTAL DAMAGE THAT CANNOT BE ISOLATED FROM OTHER SECTORS	
10. Changes in environmental goods and services flows during the restoration period of the human-made capital and natural capital: • Tourism sector (information obtained from the person in charge of the sector). Includes the fall in income due to lower takings from visitors to hotels (lower occupancy) and other tourism-related income (restaurants, gift shops, transportation, etc.). Its estimation adds up US\$18 million. Part of this damage are the lost environmental services related to tourism during the restoration period.	N/A

The following table summarizes the environmental damage assessment:

(US\$000)	Not assessed in other sector	Assessed in other sectors
Isolated from other sectors	14 722	9 658
Not isolated from other sectors		Not estimated 80 000

Figure 1

PROCESS FOR ECONOMIC ASSESSMENT OF ENVIRONMENTAL DAMAGE



The complete assessment of environmental damage includes, therefore, the damage (both direct and indirect) assessed by the sectoral specialists and that assessed by the environmental specialist.

Example 2: Assessment of damage to the environmental services provided by forests

This example concentrates on the assessment of damage to the environmental services provided by forests, since this is one of the most likely effects of an extreme event. The event has been simplified to show only this damage, and there is no analysis of links to other sectors.

An extreme event has affected a region in a country in the following way:

- Primary forest: 3 200 hectares destroyed. Most of the area cannot be recovered or is recoverable in the very long term.
- Secondary forest: 6 100 hectares destroyed. Most of the area cannot be recovered or is recoverable in the very long term.
- Shade coffee plantations: 7 200 hectares affected, of which 60% (4 320 hectares) is considered incapable of recovery. The remaining 2 880 hectares might recover over a period of five years.

- 38 The country's government has introduced a scheme whereby landowners who conserve the forests will be paid for environmental services. This payment will be made for 20 years. The environmental services and annual monetary values included under this scheme areas follows: ²⁸

Table 5
VALUE OF THE FOREST ENVIRONMENTAL SERVICES

Environmental Service	Primary forest (USD/ha/year)	Secondary forest (USD/ha/year)
<i>Carbon fixing</i>	38	29
<i>Water protection</i>	5	3
<i>Biodiversity protection</i>	10	6
<i>Recreation (natural beauty)</i>	5	3
Total	58	41

²⁸ The World Bank uses the figure of 20 dollars per ton of carbon emitted as an estimate of the damage caused by carbon dioxide emissions. This figure represents the current value of the damage to economic assets and the fall in human well-being for the time the polluting unit is in the atmosphere. There is still no agreement as to the carbon sequestration capacity per type of vegetation.

The shade coffee plantations are agroforest systems that provide agricultural products while conserving the ability to provide typical forest environmental services. An environmental assessment study of the area has taken into account the provision of one good (firewood) and three environmental services (protection of water production and flood control; soil stabilization and conservation; and maintenance of biodiversity). The study does not take into account the environmental service of carbon fixing because the branches cut in the annual pruning are burned.

There is an estimated timber production of 14 m³/ha/year with a value per m³ of 56 dollars/ha/year. The value of the other three environmental services is 21 dollars/ha/year. The total value therefore is 77 dollars/ha/year.

Table 6
ASSESSMENT OF ENVIRONMENTAL DAMAGE

DIRECT ENVIRONMENTAL DAMAGE	USD\$ 000
1. Loss of environmental services provided by primary forests. <i>The method used to assess the value of the loss of the 3,200 hectares of forest is based on the government's decision to pay for the conservation of forests (i.e. there is a market for environmental services). By using the formula below with a discount rate of 7 per cent (that used by the government to evaluate its investment projects), the income from conservation over the next 20 years is expressed at its present value.</i> $VP = \sum_{t=0}^{20} \frac{58}{(1.07)^t}$ <i>The present value of the future income flows is USD 672/ha. For 3,200 ha., this comes to</i>	2,150
2. Loss of environmental services provided by secondary forests. <i>This is calculated in the same way as the previous example, but the value of the annual payment per hectare is changed as shown in the following formula.</i> $VP = \sum_{t=0}^{20} \frac{41}{(1.07)^t}$ <i>The present value of the future income flows is USD 475/ha. For 6,100 ha., this comes to</i>	2,897
3. Loss of environmental services provided by shade coffee plantations <i>In this case, it is considered that the value of the land has already been included in the farming sector assessment, although it ought to be taken into account in an extended assessment of environmental damage. The value of the environmental services taken into account is calculated for the non-recoverable area (4,320 ha) as in the previous case. The same formula is used as in the previous cases, and the value of the annual benefit per hectare is introduced</i> $VP = \sum_{t=0}^{20} \frac{77}{(1.07)^t}$ <i>The present value of the future income flows is USD 893/ha. For 4,320 ha., this comes to</i>	3,858
Total direct environmental damage	8,905
IN DIRECT ENVIRONMENTAL DAMAGE	
4. Loss of environmental services provided by shade coffee plantations during rehabilitation period <i>There is a loss of environmental services during the recovery period of the 2,880 hectares of plantations that are capable of recovery (it is considered that the necessary investment is included as direct damage in the farming sector assessment, although it ought to be included in an extended assessment of environmental damage). For calculation purposes it is considered that the production of firewood and environmental services recover linearly over five years. Therefore:</i> $VID = 2,880 \left[77 + 77 \cdot 0.8(1.07) + 77 \cdot 0.64(1.07)^2 + 77 \cdot 0.4(1.07)^3 + 77 \cdot 0.2(1.07)^4 \right]$	610
Total indirect environmental damage	610
Total environmental damage	9,515

APPENDIX XIII

LIFE ZONE SYSTEMS

The relationship between climate and vegetation has been recognized for many years, eventually leading researchers create a worldwide environmental classification system for geographically defining various habitats and natural biotas. Physical environmental factors (soils, nutrients, climate patterns, lighting, seasonality, humidity) that constitute a region's constant or cyclical characteristics are determinants in the development or presence of natural ecosystems that biologically define the area in question. These environmental parameters are the basic reference points for L.R. Holdridge's method of classifying life zones. This system recognizes discrete natural units so that they can be easily distinguished in the field, whether they consist of indigenous vegetation or forms that have been greatly altered. By employing universal parameters that can be easily measured with the same precision in any region and fed into the same model using identical formats, it is applicable to the entire globe.

The application of this system offers the following advantages:

1. Achieving a useful cartographic expression of diverse plant categories or formations that make up a region, country or continent in all of its latitudinal, and altitudinal, climatic, soil and hydrographic variations;
- 40 2. Determining the quality and potential of ecosystem services in a specific area (e. g., water production or absorption of carbon dioxide).
3. Forecasting the potential environmental impact of any human development or major natural events;
4. Choosing the areas that would be most conducive to farming, forestry or livestock activities (land use planning);
5. Identifying naturally existing communities with an eye toward stressing the importance of their conservation; and
6. Predicting bio-geographical scenarios in response to global climatic changes.

The four main analytical elements in the life zone system (Holdridge, 1979) are heat factors expressed in terms of biotemperature; the use of logarithmic increases in mean annual biotemperature and precipitation to express significant change in natural vegetation units; the ratio between biotemperature and potential evapotranspiration (humidity), on the one hand and the humidity and real evapotranspiration, on the other; and the ratio between evapotranspiration and biological productivity (Tosi, 1997), which is intimately related to environmental services.

In short, the life zone system reflects the relationship between the physical environment and all biota as expressed on three levels:

- Level 1: Bioclimate or life zone;
- Level 2: Vegetation association or ecosystems; and
- Level 3: Successional state (vegetation cover).

The system is thus based on the idea that it is possible to objectively define groups of ecosystems or plant associations on the basis of clear relationships with specific temperature, precipitation and humidity conditions. Holdridge referred to these as life zones, understood to be a group of natural associations, which are divided and subdivided accordingly, regardless of whether each group includes a chain of varying landscape or environmental units that may range from swampland to watershed. Life zones are also equally balanced between the three leading climatic principles of heat, precipitation and humidity, while recognizing that these associations may vary according to the altitudinal variations within a single region. This method of classification allows for recognition of the multiplicity of potential ecosystems or vegetable associations to be found within each of the world's 120 life zones or bio-climates. Vegetable association have been broken down into the following categories:

- One climatic association
- Three atmospheric associations
 - Temperature associations (hot, cold)
 - Humidity associations (arid, humid)
- Five soil associations
 - Humidity associations (arid, semi-arid, humid)
 - Fertility associations (fertile, sterile)
- Water associations

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Furthermore, each of these systems includes a wide range of potential successional stages from a climactic or ideal state to those marked by extreme disturbances of a natural or anthropogenic nature. In this manner, all levels of vegetation corresponding to each of the successional states can be found in a broad array of conditions defined in physiognomic rather than in floristic terms.

Verifying System Validation

The life zone system has been validated through extensive mapping of tropical and subtropical regions with comparisons between similar areas based on limited meteorological data and observations on the relationship between climate, vegetation and patterns of land use. All of the countries of Central America, as well as Bolivia, Colombia, the Dominican Republic, Ecuador, Haiti, Jamaica, Paraguay, Peru, Puerto Rico, Santa Lucia and Venezuela have been environmentally mapped based on the life zone system. In addition, a preliminary macro-scale or partial mapping has been done of Australia, Brazil, Mexico, Mozambique, Nigeria, Thailand, Timor, Papua New Guinea and the United States. In most countries, these maps are accompanied by supplementary descriptive and explanatory texts.

Life zone definition based on climatic data

According to this system, life zones are defined based on mean annual readings of temperature (biotemperature), precipitation, humidity and meters of elevation above sea level. These are defined as follows:

- **Biotemperature**: mean annual temperature in centigrade conducive to plant life (between 0 and 30°C);
- **Precipitation**: the mean volume of any form of precipitation (rain, snow, sleet) in millimeters; and
- **Humidity**: the ratio between temperature and precipitation, independent of other sources of humidity. The best formula is called the potential evapotranspiration factor (in millimeters), which is achieved by multiplying the biotemperature by factor 58.93.

The second and third levels of life zones

42 Holdridge conceived of life zones defined by parameters applicable to the entire globe, such as biotemperature, precipitation and humidity. Nevertheless, specific environmental factors play a major part in defining the ecosystems of specific local landscapes. These conditions are the framework for defining a second subdivision that includes soil type, precipitation patterns, soil humidity patterns, the prevalence of strong (damp or dry) winds and the frequency of heavy fog. The presence or absence of any of the above factors moves the area in question left or right, or higher or lower, on the Holdridge Life Zone Model.

The variety of the floristic composition and the structure and physiognomy of the vegetation of a region or country generally tends to narrow as one moves to higher elevations along the same latitudes, relative to a wet tropical rainforest with a sub-alpine landscape near the equator. A similar divergence can be seen with precipitation levels and seasonality in an arid tropical forest versus a very humid tropical forest at the same latitudes.

Within a life zone or formation, limiting factors can condition or make possible the development of many associations: mangroves, rocky coastal zones, lagoons, dry steppe, windy hills and a range of other systems.

The system recognizes four basic associations (and possible combinations thereof): climatic, soil, atmospheric and moisture conditions. Climatic associations occur when precipitation and monthly distribution such as biotemperature are normal for the life zone, there are no atmospheric aberrations such as strong winds or frequent fog cover and the soil is typical for the zone. Soil associations appear when conditions are more or less favorable in relation to those for a normal (zonal) soil for the corresponding life zone. Atmospheric associations are those in which the weather varies from the norm in that area. Moisture associations involve all forms of wetlands (whether saltwater, brackish or freshwater) but logically exclude deep bodies of water.

The broad, climatically defined life zones are further subdivided into associations based on local environmental conditions and actual vegetation cover or land use. Generally speaking, the associations tend to make the vegetation appear more arid or humid than normal for such a life zone. For example, an association of fertile soil with supplemental water from a Tropical Rainforest has a metabolism similar to that of a Very Humid Tropical Rainforest; similarly an area designated as an Arid Tropical Forest might appear to be a Very Arid Tropical Forest owing to a monsoon climate pattern with a vertisol soil that is wet in the rainy season and dry and cracked in the dry season.

The third level of the system contemplates provisional changes to ecosystems resulting from natural succession introduced by humans or animals. Life zone systems catalogue those changes as part of the successional state, and owing to their very short life span they are handled as part of land use.

One must be very careful with regard to apparent disparities between local vegetation and the corresponding life zone designation, which occasionally refers to the original vegetation of the climatic association. By the time the field survey is conducted, the area may have experienced some successional change or alteration of the climatic association. However, such a concern only arises when the system is not being applied properly. For example, wherever human activity has altered plant life, the nomenclature of the life zone should project the potential (or ideal) vegetation assuming that conditions would allow for a full recovery through a natural process of environmental succession.

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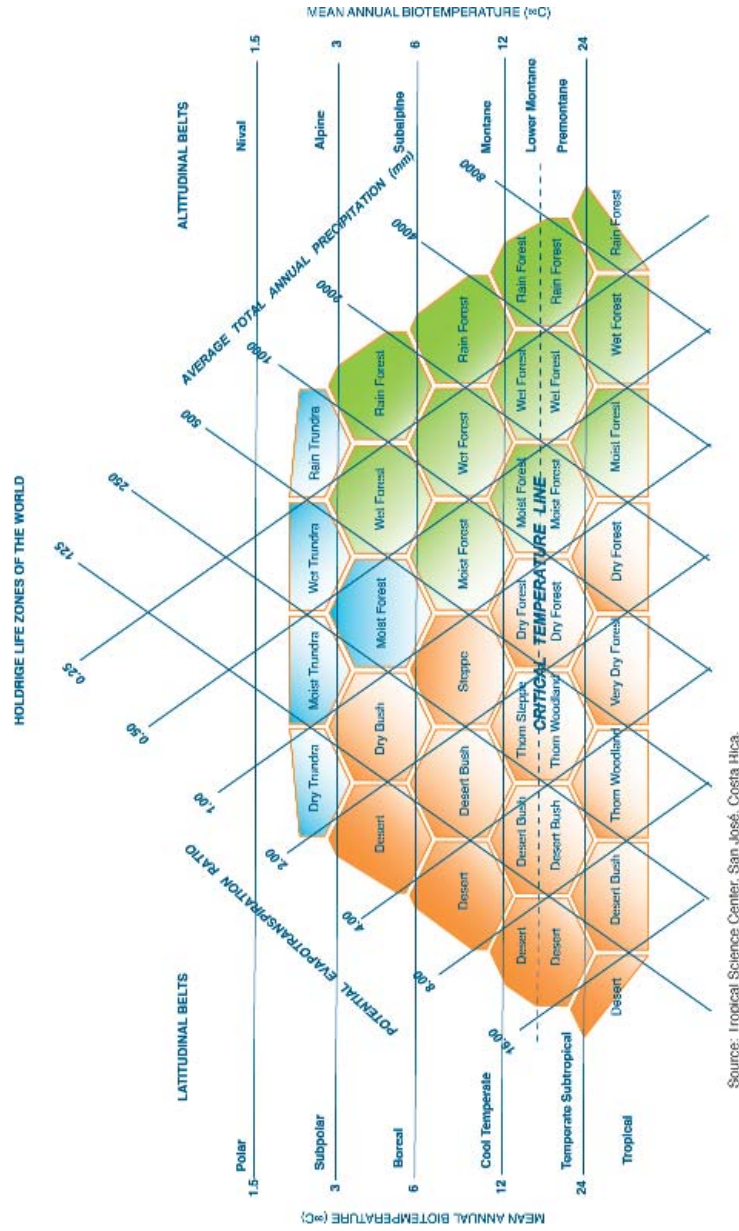
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II. THE IMPACT OF DISASTERS ON WOMEN

1. Introduction

The differential impact of disasters on women is a subject new to the Handbook. Its inclusion partly reflects a growing awareness in the international community that full development can only be achieved when women and the resources they represent are fully integrated in the development process and are empowered to improve the economic, social and political conditions of developing countries within a framework of sustainable development.¹ This addition also, and perhaps chiefly, reflects an understanding that men and women reveal vulnerabilities peculiar to their sex when confronted by disaster situations. In the face of this reality, it is essential to keep a clear gender focus to be able to support women facing a disaster and to reinforce their capacity to overcome these situations. Such an awareness can reshape reconstruction tasks or projects.

Rather than making the differential impact of disasters on women and their role in reconstruction a separate sector in this analysis, we treat it as a broad theme that cuts across the entire spectrum of social, economic and environmental sectors. Similarly, this theme should not be considered the exclusive province of women, nor should analysis of such issues be relegated exclusively to a team member chosen to conduct gender analysis. Instead, it should be seen as a social subject of multisectoral scope on which all specialists in each discipline must cooperate.

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Just as a post-disaster reconstruction programme contains projects meant to re-establish production in a given sector, it must contain projects addressing the specific needs of vulnerable social groups. Such initiatives make it possible to mend the torn fabric of society while facilitating economic recovery. It is thus essential to determine the specific impact on the women of an affected country or region in order to design actions and projects that help to reduce their opportunity cost and increase their ability to recover. Disasters should also be seen as an opportunity to improve pre-existing conditions, including sex equity. Reconstruction, therefore, should not be thought of simply as a process of replacing what has been lost, but also as an opportunity to perform actions that make the most underprivileged groups less vulnerable, favor sex equity and improve living conditions for women, especially those who are heads of households.

¹ See, for example, page 14 of *Directrices y guía de conceptos del Comité de Ayuda para el Desarrollo sobre la igualdad entre mujeres y hombres*, published by the Office for International Cooperation and for Latin America, Ministry of Foreign Affairs, Madrid, 1998.

One of the consequences of a disaster is the decapitalization of women and the reduction of their share of productive activities in the formal and informal sectors. Not only do they sustain direct damages or production losses (housing and means of production), but they also have relatively high opportunity costs because they lose income when they have to apply themselves temporarily to unpaid emergency tasks and an increased amount of unpaid reproductive work, such as caring for their children when schools are closed because they are being used as shelters for disaster victims.² Such reproductive work is usually granted a lower status than paid work because of the greater physical toll that it takes on women. It is also a continuous job, without weekends off or vacations, which limits women's mobility and can sometimes even prevent them from exercising their rights as citizens.³

Regardless of who the head of the household might be, women's contributions to family budgets are as important as men's. Although a woman might not hold a paid job, she may generate household income from a variety of informal sector activities, whether from the backyard economy or from a small home-based business, thus allowing her to combine productive tasks with reproductive ones. Activities of this sort (both productive and reproductive) are not included in official national accounts. However, if the income from them were to be taken into consideration, we would see that men and women more evenly contribute to sustaining a household.

46 Although the differential impact of disasters on women should be treated transversally throughout the damage assessment (both in their sectoral and geographic dimensions), we have chosen to handle it on two levels in this Handbook. The first is by including in each sector (whether social, economic or environmental) an additional section about the way in which a disaster's differential impact on women should be assessed. The second is to include this separate chapter on how to obtain a preliminary estimate of the total impact of a disaster on women and how to orient reconstruction projects towards them.

It must be clearly borne in mind (and a mention made of the fact in the assessment report) that this transversal assessment is not fully comparable to overall economic impact findings inasmuch as some valid parameters for the assessment of the impact on women are not included in national accounts. It is also important to avoid problems of double accounting by simply folding the impact on women into the other sectoral assessments, which should have already contemplated such damage and losses.

² Reproductive work is defined as activities required to renew the work force (child care, education of future generations of human resources, provision of meals, etc.), ensure the availability of its productive members (housekeeping, provision of meals, personal care and attention in home and community) and care for those who are no longer active members of the work force because of age, sickness or handicap.

³ Gálvez P., *Thelma, Aspectos económicos de la equidad de género*, p. 20, Serie Mujer y Desarrollo No. 35, ECLAC, Santiago de Chile, June 2001.

2. The overall impact of a disaster on women

Each sectoral specialist should produce the most detailed information possible needed to ascertain a disaster's overall impact on women. The following is a description of one approach to measuring that impact. As in the other sectors covered in the Handbook, damages are classified as direct (i.e., on property) or indirect (i.e., on economic flows).

a) Direct damages

The quantification of all the direct damages sustained by women should take into account all the property they possess.⁴ When the head of the household is a woman, this covers loss of or damage to the dwelling itself, as well as household furnishings and appliances. If she runs a home-based workshop or micro or small business, the assessment should include its equipment and machinery, as well as any other productive property she owns. It should include her farm animals, fields and crops if she is engaged in activities in the so-called backyard economy. In all of the above cases, evaluations should include stocks of goods produced, whether stored at home or nearby.

Damage estimates for such property belonging to women will come directly from the sectoral assessments, in which damages will have been broken down by sex. Only the part that refers to damage in the private sector will be used. For this reason, the women's specialist should refer to the corresponding chapters in each relevant sector and co-operate directly with each of the sectoral specialists in estimating and breaking down the data.

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b) Indirect losses

While the Handbook considers ways of estimating most indirect losses by following the instructions for separating damages by sex, there are also indirect losses that only affect women, namely, those that are related to the increase in reproductive work created by the disaster and its aftereffects. Therefore, a methodological innovation is required.

Indirect losses sustained by women have four main components: loss of productive employment outside the home; loss of household production and income, including that of the backyard economy and of small or micro - businesses run by women from home; the increase in reproductive work; and other damage of a financial nature stemming from outstanding debts or loans.

i) **Loss of productive employment outside the home and related income.** This refers to the temporary loss of a paid job that a woman holds outside her home, whether its nature is domestic, industrial or commercial or, for that matter, technical, professional or executive. Such temporary unemployment stems from damage caused to formal production systems, and its duration will depend on the time needed to re-establish or reconstruct them.

⁴ The backyard economy includes the rearing of poultry, goats, sheep and pigs, as well as the benefit obtained from milk, eggs, wool, etc. It also includes fruit trees and produce grown on small plots located near the home.

Once again, estimates under this heading should be taken directly from the sectoral assessments or from the employment assessment, and the women's specialist should cooperate with the sectoral specialists to facilitate the breakdown of damage by sex.

In any case, the value of this indirect damage is obtained by multiplying the number of days or weeks during which remunerated employment is interrupted by the average unit wage for each level of income. Unit wages should be those used for each of the sectors. (The sources from which they can be obtained are described in the relevant chapters and are not repeated here). Obviously, the period of temporary unemployment for women should coincide with that used for analysis purposes in the other sectors.

ii) **Loss of household production and income.** Here we strive to estimate the temporary loss of production and income from home-based women's enterprises, regardless of whether the head of the household is a woman. These temporary losses include those sustained in the backyard economy and by micro and small enterprises run by women from their homes.

Partial estimates of temporary losses in the backyard economy are made by either the housing or the agriculture specialist, who must work with the women's specialist to estimate the losses for each sex and to make a joint recovery-time estimate for the activity in question. A sampling of affected women is also needed to determine whether the estimates made by the sectoral specialists include all the components of the backyard economy or whether additional estimates will be required.

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Production losses in formal sector small and micro businesses are normally assessed by industrial, commerce and services sectors analysts. The employment specialist cooperates closely with them to estimate or measure the unemployment or temporary loss of income caused by the temporary interruption of production in these areas. The women's specialist should also work closely with those analysts to separate this indirect damage by sex. As with the backyard economy, it is useful to undertake a sampling of the affected women to ensure that all losses have been included and to determine whether the estimates of the sectoral specialists should be supplemented with additional estimated data from the sampling.

Similar cooperation between the women's specialist and those focused on industry, commerce and services is also necessary to assess the lost production in women-owned, home-based small and micro businesses in the informal sector that may have been destroyed or damaged. The method for estimating or measuring losses of this sort is described in the relevant chapter. The same specialists should work together to estimate the time it will take for production to recover.

iii) **Increase in women's reproductive work.** Disaster situations always bring an increase in women's unpaid reproductive work. The greater physical workload and emotional toll must be quantified if the total impact of a disaster on women is to be ascertained. This task is the responsibility of the women's specialist, who may require support from other members of the assessment mission in the form of relevant information about each sector's activities, the way they have been affected and, most importantly, how long women's increased reproductive responsibilities are likely to last.

Estimates of the increase in women's reproductive work should be made in comparison to a baseline situation, which has to be established for each particular case. Different patterns of reproductive work may be found in the same country depending on the customs or environmental and spatial conditions (e.g., urban and rural) of the affected areas. It is necessary to make a list of common forms of reproductive work activities, for which analysts must examine the relevant literature, speak with local specialists and undertake a quick sampling, when feasible. If no such quantitative information is available, data can be obtained from a sampling of affected women; failing this, one may assume that they dedicate at least eight hours a day to this unpaid work.

Later it will be necessary to determine the new pattern of reproductive activities that women have to perform as a result of the disaster, based on either representative samplings or, if this is not possible, estimates. In addition to the usual baseline activities cited previously, this assessment should consider that women have assumed new activities connected with the performance of emergency-related tasks, rehabilitation and reconstruction, and that other activities they performed previously will now take longer.

Typical examples of reproductive tasks during the post-disaster stages are volunteer work in refugee camps and time spent queuing to receive food. When gauging the increased time devoted to household work one should include the additional time spent hauling water and collecting firewood because usual sources have been damaged or curtailed; collectively preparing meals in refugee camps; caring for children whose schools have been closed; purchasing goods that require transport along roads in bad state of repair; and so forth.

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By comparing the time dedicated to reproductive work, in the post-disaster situation with the normal or baseline situation, it is possible to determine the additional time (with the appropriate disaggregations or spatializations) women spend in reproductive work every day due to the disaster.

This calculation should be expressed in monetary terms; perhaps the only way to accomplish this is to make a suitably adjusted comparison with the value of productive work. For example, the average monthly wage for women (separated at least into urban and rural wages) could be divided by 30 eight-hour days instead of by 22 working days.

To determine the total amount of the disaster-related increase in women's reproductive work, one should estimate the duration of the abnormal situation, which will undoubtedly vary for each activity, area or sector, depending on the type and severity of the damage. The women's specialist should cooperate closely with each of the sectoral specialists to ascertain, or at least estimate as precisely as possible, the different factors that will determine the duration of each situation that increases women's reproductive work.⁵

⁵ For example, the time needed to restore the electricity or water supply and to refurbish housing (whether rural or urban) or schools is a key determinant, since these factors force women to spend more time on reproductive work.

Once the value of the additional time spent in reproductive work and the duration of the different post-disaster recovery situations have been ascertained, it will be possible to estimate the total indirect cost arising from the increased reproductive work that can be validly attributed to the disaster.

Care should be taken to avoid double accounting. When a disaster forces a woman or group of women to temporarily perform reproductive rather than productive work, only the income lost as a result of being temporarily suspended from paid work should be taken into account. The lost pay will undoubtedly be higher than the value of the temporary increase in reproductive work.

iv) **Other indirect damages.** Women frequently purchase goods through formal or informal credit as a way to increase their and their families income or to improve the quality of life. Such goods might be damaged or completely lost because of a disaster before the credit has been completely repaid.

50 Strictly speaking, to avoid double accounting when the loss of a good purchased in this way is already recorded as part of direct damages to family property or housing one should not add the amount of the outstanding balance of the credit to the value of the lost goods (as housing, trade, industry or services specialists routinely do). It is, however, valid to include penalty interest that may be charged for late payment of the outstanding balance until the woman once again begins to earn her normal income. A further item that could be recorded under the heading of lost goods is the higher amount of interest that a woman would have to pay if she were to refinance the debt so as to include not only the outstanding balance, but also new funds with which to buy new goods to replace the goods that were lost.

An example of how to assess the impact of a disaster on women is presented in Appendix XIV. It is based on information obtained during the earthquakes that occurred in El Salvador in early 2001.

3. Sources of information

Basic information on women's participation in social and economic activities can usually be found in population censuses. In many Latin American and Caribbean countries, the 2000 censuses have already been started or completed. If the results of these recent censuses are not available, specialist can use information from the most recent household surveys, which are regularly carried out in the countries. Information from both censuses and household surveys can be obtained from each country's statistics office.

A second local source of information on women's participation in development activities is the Human Development Report published annually by the United Nations Development Programme (UNDP). This can be obtained from any local UNDP office.

Finally, national universities and organizations that promote sex equality usually have a large amount of relevant documented information. The gender specialist should also consult these organizations to obtain additional relevant information and to elicit their assistance for any rapid surveys or samplings that may be needed during the assessment.

Basic information on the subject may also be found in the ECLAC Annual Statistics, which offers comparable data from different countries. Further information about populations and their characteristics appears in the publications and on the web page of the Latin - American Demography Center (Centro Latinoamericano de Demografía – CELADE). Updated country information from the Gender Index System (maintained by ECLAC's Women and Development Unit) is available at <http://www.eclac.org/mujer/>.

CELADE's Redatam software uses information from the censuses and household surveys of a country or any of its geographical or political subdivisions, thus enabling the specialist to determine the distribution of any variable to be analyzed. It is easy to use, and its usefulness in assessing the impact of disasters was demonstrated in the 1999 flooding in Venezuela and the earthquakes in El Salvador in January-February 2001.

APPENDIX XIV A REAL CASE EVALUATION

This appendix describes the assessment of the overall impact on women of the earthquakes that affected El Salvador in January and February 2001.⁶ It is based on information described in documents prepared by ECLAC for each of these events, as well as on information obtained through a sample survey undertaken by a consultant on gender issues who was part of the ECLAC assessment team.⁷

1. Assessment of direct damages

The direct damage assessment is based on individual assessments made by the specialists in each of the affected sectors. As we briefly describe below, several different procedures and sources of information were used to prorate the value of direct damage between sexes.

a) Housing

52 The method used to place a value on direct damage caused to women's share of housing was to identify the amounts contributed by each gender to the household's total income. An alternative would have been to try to obtain figures on the ownership by sex of each affected dwelling, but this would have been too time consuming and would not necessarily have provided a fair view of the way in which the cost of the dwelling was financed. A previous nationwide study revealed that on average women's contribution to the home was equal to or greater than men's in 49% of urban households and in 56.6% of rural households.

Once the amount of direct damage to urban and rural dwellings (including furniture, other goods and appliances) had been ascertained and multiplied by the above coefficients, it was estimated that damage to women's household property amounted to 146.1 million dollars. ECLAC's methodology for assessing housing damage contemplates 70% to 80% of lost or damaged assets in women's backyard economy, so care should be taken to avoid double accounting later on.

b) Industry, trade and services

In this case, use was made of available statistics on women's share of the ownership of industrial, commercial and service establishments. These showed that women owned 40% of small and micro industrial businesses, 60% of commercial businesses and 71% of service businesses. Large industrial and maquila businesses were exclusive male domains.

⁶ ECLAC, *The January 13, 2001, Earthquake in El Salvador: Socio-economic and Environmental Impact*, (LC/MEX/L.457), Mexico City, February 21, 2001, and ECLAC, *El Salvador: Assessment of the Tuesday January 13, 2001, Earthquake*, (LC/MEX/L.457/Add.2), Mexico City, February 28, 2001.

⁷ Arenas Ferriz, Angeles, *Estimate of Damage to Production Activities of Women who Lost Their Homes and the Shadow Value of Their Work in the Emergency and Rehabilitation and Reconstruction Tasks* Madrid, 2001.

Once the specialists for each of these sectors had estimated the value of property lost in each of the subsectors or activities where women held a significant share, it was multiplied by the above percentages. On this basis, it was calculated that total damage to women's share of the property in these sectors amounted to 117 million dollars.

c) Backyard economy

This heading includes the women-owned assets located at home that are used to produce foodstuffs for the family's own consumption, as well as for occasional sale. A relatively large percentage of these losses was already measured in the housing sector for urban areas and in the agricultural sector for rural areas.

The housing and agricultural sector specialists had estimated the value of the loss of productive assets and of domestic animals in homes. Nevertheless, a detailed analysis, including information from a survey among affected women, showed that damage to backyard economy assets had not been included in sectoral estimates and that their value would amount to about 20% of the damage to household goods and appliances in the housing sector, plus a similar percentage for damage to sheep, goats and pigs. The direct loss to backyard economy assets was estimated at 37.7 million dollars.

2. Indirect losses

a) Loss of employment outside the home and related income

Information about the number of jobs lost because of damage caused by the earthquake was available because the employment specialist worked together with the sectoral specialists to develop these figures. The UNDP's Human Development Report for 2000 was the source for data on women's share of jobs in each of the productive sectors and their average monthly income figures.

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The survey undertaken by the women's specialist was a source of additional information, especially about women workers who lost their jobs; it corroborated, and in some cases supplemented, the estimates made by the sectoral specialists.

The available information covered jobs lost by women in assembly plants and in the agricultural sector, specifically in activities related to coffee and fisheries. In the case of women domestic workers, rough estimates were made based on the assumption that 15% of the women workers in the 150 660 homes destroyed had lost their jobs. The findings of the survey corroborated these figures. In each case, the urban or rural monthly wage was used, as appropriate. When calculated over the five-month period required for the most immediate rehabilitation and reconstruction activities, this yielded the results shown below:

	Months	USD/month	Millions of USD
Agriculture	3,700	111.03	0.4
Small, micro, med. bus.	105,750	226.60	24.0
Maquila	...	226.60	...
Domestic service	45,400	226.60	10.3

Therefore, the total amount of income from paid employment lost by women was estimated to be 34.7 million dollars.

b) Lost production in the home

For this heading, it was necessary to combine some of the lost-production data from the sectoral estimates with data obtained from the survey of affected women.

Specifically, estimates of backyard economy production losses, based on information obtained from the survey, were incorporated after verifying that they had not been included in the calculations by productive sector specialists. Future losses in backyard economy production for the five-month period were estimated at 25 million dollars.

A similar calculation was made to estimate losses in home-based productive activities (the small workshops or micro businesses operated by women from their homes). The information obtained from the survey of affected women made it possible to make a preliminary estimate of 91.8 million dollars, from which was deducted the amount of losses already measured and recorded by the specialist in the commerce, industrial and services sectors for small and micro businesses not based in the home (24 million dollars). In other words, this type of home-based activity was estimated to have lost production over a five-month period worth 67.8 million dollars.

54 Estimates of the increased amount of reproductive work among affected women were made based on survey data that revealed that urban and rural women in El Salvador devote an average of eight hours per day to reproductive work, over and above the time that they spend on their productive activities. The survey also showed that during the five-month rehabilitation and reconstruction period, women's daily reproductive work swelled to 14 hours in the urban sector and to 16 hours in the rural sector as they queued for food, helped to take care of children, the aged and sick, and obtained water from more distant sources.

A value of 1.29 dollars per hour was set on urban women's time. This figure was calculated by dividing the average urban monthly wage by 176 (eight hours per day for 22 days a month). In the case of rural women, a value of 0.46 dollars per hour was adopted. The latter figure was obtained by dividing the average rural monthly wage by 240 (eight hours per day for 30 days a month). These estimated losses amounted to 276.5 million dollars.

c) Other indirect losses

The amount of penalty interests that women would will have to pay because their earnings were significantly reduced during the period of rehabilitation and reconstruction was calculated on the basis of information gathered during the survey with regard to their outstanding credit balances.

This showed that 43% of women in the urban sector had an average debt of 240 dollars, while 35.5% of rural women had an average debt of 1 600 dollars. When a penalty interest rate of 3.5% was charged on these amounts for five months, the loss to the women was estimated to be 21.1 million dollars.

3. Summary of damages and losses

In the following table, the cost of direct damage to women's property has been added to formal and informal income lost by women. The result is the total amount of damage sustained by women.

Table 1

Type of damage	Amount, millions of USD
Direct damage	300.8
<i>Housing, furniture and appliances</i>	<i>146.1</i>
<i>Industry, trade and services</i>	<i>117.0</i>
<i>Backyard economy property</i>	<i>37.7</i>
Indirect damage	414.4
<i>a) Loss of employment outside the home and income there from⁸</i>	<i>(34.7)</i>
<i>Lost production from home-based activities</i>	<i>116.8</i>
<i>Backyard economy</i>	<i>25.0</i>
<i>Informal micro and small businesses</i>	<i>24.0</i>
<i>Productive activities</i>	<i>91.8</i>
<i>Increase in reproductive work</i>	<i>276.5</i>
<i>Other damage</i>	<i>21.1</i>
Total damage	715.2

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These estimates show that total damages sustained by women in El Salvador because of the earthquakes would amount to 715.2 million dollars. Forty-two percent (300.8 million dollars) of the total represents decreases in assets owned by women before the disaster, while indirect losses of production and income account for the remaining 58% (414.4 million dollars). Total indirect losses totals (duly subtracted from the figure for lost earnings through unemployment outside the home to avoid double accounting) were valued at 241.8 million dollars for increased reproductive work, 116.8 million dollars for informal and formal production losses and an estimated 21.1 million dollars in penalty interests on outstanding debts at the time of the disaster.

These figures apply exclusively to women in the private sector. If the prorated damage in the public sector of which women are also users were added, the total damage sustained by women would amount to 1.004 billion dollars, or 314 dollars per capita. These figures cannot be validly compared to per capita income or GDP, since they include values for items such as the backyard economy and women's reproductive time, which are not recorded in the national accounts.

⁸ This amount should be deducted from the total so as not to partially duplicate the figure for the increase in reproductive work.

III. DAMAGE OVERVIEW

1. General comments

Once the social, economic and environmental impacts of a disaster have been assessed, a recapitulation of damages is needed to arrive at an analysis overview, which marks the culmination of the assessment and lays the basis for the subsequent macroeconomic analysis. It should include the total amount of damage and losses, together with breakdowns that identify the most affected sectors, geographic areas and population groups. In addition to quantifying the total impact in monetary terms, this overview must make it possible to identify the sectors and geographical areas requiring priority attention, thus serving as an invaluable input for defining reconstruction strategies, plans and projects.

Based on the sectoral estimates made using the uniform assessment methodology discussed in previous chapters, the overall damage assessment specialist must prepare a summary of both direct damage and indirect losses in order to arrive at a figure for the total amount of damage caused by the disaster under analysis.

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Special care must be taken to avoid double accounting: damage recorded in one sector must not be included under another sector, a common mistake in the case of indirect losses related to production chains (for example, production, processing and commercialization). Similar care should be taken to ensure that the total damage estimate includes only losses that can be measured in terms of national accounts. Other cases, such as the differential impact of the disaster on women or on the environment, require somewhat different estimation procedures.

Once total damage and losses have been estimated, selected breakdowns will be required to provide a complete overview of the general impact of the disaster and to enable future comparisons. The following three types of breakdowns should be made:

- Total direct damage and indirect losses;
- Total damage to assets and production and increased costs or decreased income in the provision of services; and
- Total damage to public and private sectors.

The distinction made between total direct and indirect damages facilitates projections of the effects on assets and on future economic performance, respectively. The amount of direct damage is a measure of the efforts that will have to be made in order to replace lost assets in the affected country or region. Indirect losses or effects reflect changes in economic flows that will be used by the macroeconomics specialist to project post-disaster economic performance in the affected country or region.

The breakdown into damage to assets and production, and on the one hand changes in costs and income in the provision of services, on the other, will enable a further analysis to identify asset losses, decreases in production, effects on national finances and the impact on enterprises that provide public services, as well as possible increases in the population's cost of living. Direct damages include both destroyed assets and losses of production that was ready for consumption at the time of the disaster.

These two types of direct damages must be estimated separately to allow for subsequent macroeconomic analysis. Indirect effects include future production losses, as well as higher costs and decreased revenues in the provision of services such as water and sanitation, electricity and transportation. Therefore, this second breakdown will provide a measure of total damage and losses of assets and production, as well as the indirect effects on the finances of the public sector and of both public and private enterprises that provide basic services.

The breakdown of the total damage into public and private sectors will enable the determination of some characteristics of reconstruction programmes, by defining the relative efforts required from the state and from private individuals or enterprises. Even though the cost of reconstructing public infrastructure must be met by the government—which allows a determination of the amount of future public financing requirements—the latter may also have to establish financial schemes or credit lines for the private sector affected by the disaster, especially in the case of the lowest-income population or of strategic sectors of the national economy.

In addition to the breakdowns described above, the damage overview specialist must determine how total damage was distributed among sectors in order to identify those which were most affected and which, therefore, should be given the highest priority in the reconstruction strategy and plans.

3. Net damages

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Insurance of assets and production is becoming common in Latin America and the Caribbean. Therefore, a net amount of damage can be obtained by deducting insurance payments from the total amount of damage. However, insurance coverage varies from country to country and within subregions.¹ The damage overview specialist should determine this net damage figure on the basis of information provided by the sectoral specialists.

Moreover, major foreign consortia usually reinsure local insurance companies. There can be a significant positive effect derived from foreign currency inflows in the form of reinsurance payments. This effect must also be estimated so that the macroeconomic specialist can use it in the subsequent analysis of future (national or local) economic performance.

4. The costs of reconstruction

As mentioned in the introductory chapter of this handbook, reconstruction costs are not equal to total damages. Damage is estimated as the present value of lost or damaged assets, whereas replacement must take into account price increases on construction and goods, as well as the additional cost of disaster prevention and mitigation measures. Therefore, the damage overview specialist must also determine total reconstruction costs using information provided by the sectoral specialists.

¹ The degree of insurance coverage and a country's level of development would seem to be correlated, with the exception of the Caribbean where—probably due to the influence of the former colonial powers—the degree of coverage of assets tends to be high.

There is another noteworthy difference between the total amount of damage and the cost of reconstruction. The cost of reconstruction includes the replacement of lost assets but excludes the value of production losses and the amount of increased spending and decreased revenues in the provision of services. It must also include the financial cost of reactivating production when necessary. One example of the latter would be the amount of credit required to refinance producers in various sectors when they have sustained significant damage or losses in their activities, such as farmers who need to refinance equipment loans when flooding or drought has caused the loss of harvests. Therefore, the cost of reconstruction will unavoidably be different from the total amount of damage caused by a disaster. When direct damages constitute a high fraction of total damages, the cost of reconstruction can be significantly greater than the total amount of damage. On the other hand, when indirect losses are greater than direct damages, as in the case of floods or droughts, the cost of reconstruction would be lower than the total amount of damages.

5. The magnitude of the disaster

To determine the impact that a disaster will have on the affected region or country, the total amount of damages must be compared to regional or national variables. This comparison will provide an indication of the reconstruction efforts required, and a measure of whether the affected region or country has sufficient capacity to face reconstruction by itself or requires foreign cooperation. The magnitude of the disaster may be determined by comparing the total amount of damage and its components and macroeconomic variables, such as:

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- Total amount of damages as a percentage of GDP;
- Total amount of production losses as a percentage of GDP or the country's exports;
- Total amount of lost assets compared to the annual rate of gross fixed capital formation, local construction sector output or the national debt; and
- Total amount of damage as a function of the population of the country or region affected.

The comparison between the total amount of damage and GDP provides a measure of the impact a disaster might have in terms of a country or region's economy. In small Latin American countries or Caribbean islands, the magnitude of a disaster might constitute a high proportion of GDP or even be greater than its total, whereas larger economies may easily absorb the effects of disasters of limited scope.² This type of comparison also reflects the intensity of efforts that the country will have to make during recovery and reconstruction.

² In this regard, Hurricane Mitch caused total damages in Honduras that represent 79% of GDP for the preceding year; the floods in Venezuela in 1999 caused total damages that exceeded 166% of the GDP in the state of Vargas; and the 1985 Mexico City earthquake caused total damages amounting to approximately 4% of national GDP.

A comparison between total production losses and GDP gives an idea of the general effect of a disaster on national or regional production or on future economic growth, whereas comparing production losses against exports might indicate the impact on the foreign sector of the affected country or region.

The comparison between the amount of damage to assets and the annual gross rate of fixed capital formation indicates the additional effort the country will have to make in construction. The comparison with the construction sector's domestic output gives an indication of the national capacity for reconstruction and of the period required to carry it out. The comparison between damage to assets and the amount of national foreign debt of the affected country can provide an idea of how much debt will have to be assumed to finance the reconstruction effort.

Determining the amount of total per capita damage and the ratio of damage to per capita GDP provides an idea of the negative effects on the living conditions of the affected population. It also provides a means of comparing the effects of different disasters occurring in the same country at different times or in different places.

6. The geographical distribution of damages

The Redatam tools described in the section on social sectors allow one to determine the geographic distribution of total damages and identify the most highly affected regions or geopolitical entities that, therefore, must receive priority attention in reconstruction plans.

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The damage overview specialist, in close cooperation with the geographic information systems and population specialist, must determine the spatial distribution of total damage and damages per capita. This will provide more accurate estimates of how the population has been affected. It is a good idea to produce maps showing the geographic distribution of damage per inhabitant and of the ratio between per capita damage and GDP.

Such maps can be combined with those that describe the distribution of poverty in a given country, thus giving decision makers a tool for defining a geographical distribution of resources for reconstruction.

7. The identification of the effects on vulnerable groups

On the basis of sectoral analyses, the damage overview specialist must be able to identify the most highly affected population groups. These must include the lowest-income groups –the map that shows the spatial distribution of total damage compared to per capita income or GDP is a very useful tool for this purpose– along with women, children and the aged and the population involved in micro and small enterprises.

APPENDIX XV

AN EXAMPLE OF DAMAGE RECAPITULATION ANALYSIS

The recapitulation of damages caused by the earthquakes that struck El Salvador on January 13 and February 13, 2001, is described below to illustrate the type of analysis required in this regard.

The total amount of damage and losses caused by the earthquakes of January and February 2001 in El Salvador was estimated at 1.6 billion dollars.

Of this amount, 58% (939 million dollars) consisted of direct damages, and the remaining 42% (665 million dollars) of indirect effects or losses. Thus, the country's assets sustained the greatest damage, with the rest affecting economic flows throughout 2001 and in subsequent years. The following table details the aforementioned figures.

Tabel A

SUMMARY OF DAMAGE CAUSED BY THE JANUARY AND FEBRUARY EARTHQUAKES IN EL SALVADOR (Millions of dollars)

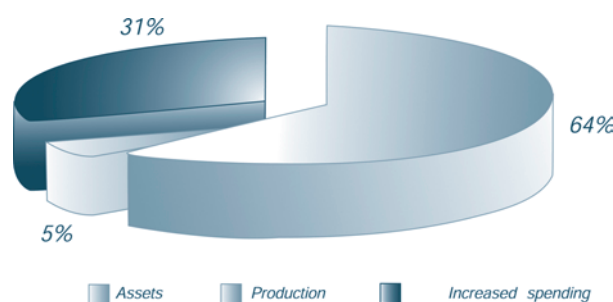
Sector and subsector	Damage			Property	
Totals	1,604	939	665	567	1,037
Social	617	496	120	238	379
<i>Education and culture</i>	211	190	20	69	142
<i>Health</i>	72	56	16	72	--
<i>Housing</i>	334	250	84	97	237
Infrastructure	472	97	375	171	301
<i>Electricity</i>	16	3	13	3	13
<i>Water and sanitation</i>	23	19	4	13	10
<i>Transportation</i>	433	75	358	155	278
Productive sectors	339	244	96	15	324
<i>Agriculture and fisheries</i>	93	39	55	13	80
<i>Industry and commerce</i>	246	205	41	2	244
<i>Environmental affects</i>	103	102	1	103	--
<i>Other damages and expenses</i>	73	--	73	40	33

Source: ECLAC estimates

The total amount described above can be broken down into the following types of damage or loss:

Type of damage	Millions of dollars
Asset losses	1,025
Production losses	84
Increased spending and decreased income	495

These figures reveal that most of the damage was to physical infrastructure and equipment (64% of total damage), followed by an increase in costs and diminished income in the provision of some services (mainly transportation) (31%) and losses in production (5%); this breakdown is presented in the pie chart below. This damage distribution coincides with the patterns expected of such geological phenomena.³



The fact that two-thirds of the total damage was to privately owned property and only a third to public properties is of special relevance, since this suggests characteristics the reconstruction program is likely to assume.

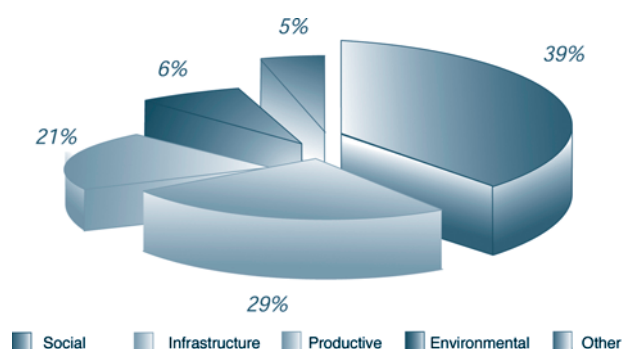
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The distribution of total damage among affected sectors is as follows:

Sector	Damage, millions of dollars
Social	617
Infrastructure	472
Productive	339
Environmental	103
Other damages and costs	73

³ In the case of disasters caused by hydro-meteorological phenomena, most losses are in production activities. In this regard see Jovel, Roberto, Natural Disasters and Their Socio-economic Impact, in *ECLAC Review*, No. 38, Santiago, Chile, 1986.

As the following figure shows, social sectors felt the brunt of the impact (sustaining 39% of total damages), followed by infrastructure (29%), productive sectors (21%) and the environment (6%).



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The hardest hit individual activities or sectors were transport and communications (433 million dollars), housing and human settlements (334 million dollars), industry and commerce (246 million dollars) and education and culture (210 million dollars). See Table A, above.

The total amount of damage (1.6 billion dollars) is by itself very high, but it must be put into context to better understand its impact on national economic development and the population's living conditions. Total damage was equivalent to 12% of the country's GDP and slightly over 40% of national exports for the previous year (2000). Damage to assets was the equivalent of 42% of the annual rate of gross fixed capital formation and about four times construction industry output.

The earthquakes' impact on the national economy obviously should not be underestimated, but nationwide data fail to fully convey the true dimension of the tragedy.⁴ Most of the damage was sustained precisely by the social sectors –housing, education and health– and by the productive sectors of industry and commerce, in particular small producers and entrepreneurs and the lower-income strata of the population.

⁴ By way of comparison, 1988's Hurricane Mitch caused damages equivalent to 13% of the GDP of the entire Central American region. Moreover, reconstruction would have taken at least four years even if it had been possible to focus the construction industry's entire capacity on that endeavour.

Geographic or spatial distribution analysis also helps to demonstrate the magnitude of the impact of the disaster on the population. The following table presents such a breakdown for each department in the country, showing total and per capita damage, as well as the ratio between total damage and GDP in each of the affected geopolitical entities.

Table B
SPATIAL DISTRIBUTION OF DAMAGE CAUSED BY THE JANUARY 2001
EARTHQUAKES IN EL SALVADOR

Departament	Total damage, in million US\$	Per capita damage US\$ per inhabitant	Per capita GDP, US\$ per inhabitant ⁵	Total damage versus GDP,%
Ahuachapán	20.3	64	2,242	2.9
Cabañas	3.5	23	2,191	1.1
Chalatenango	1.4	7	2,578	0.3
Cuscatlán	147.1	735	3,335	22.1
La Libertad	263.6	399	5,121	7.8
La Paz	270.5	943	3,020	31.2
La Unión	4.1	14	2,803	0.5
Morazán	0.8	5	2,475	0.2
San Miguel	47.5	101	3,526	2.9
San Salvador	199.5	103	4,142	2.5
San Vicente	243.7	1,533	2,671	57.4
Santa Ana	94.7	175	3,356	5.2
Sonsonate	127.0	289	3,252	8.9
Usulután	180.4	534	2,789	19.1

Source: ECLAC estimates.

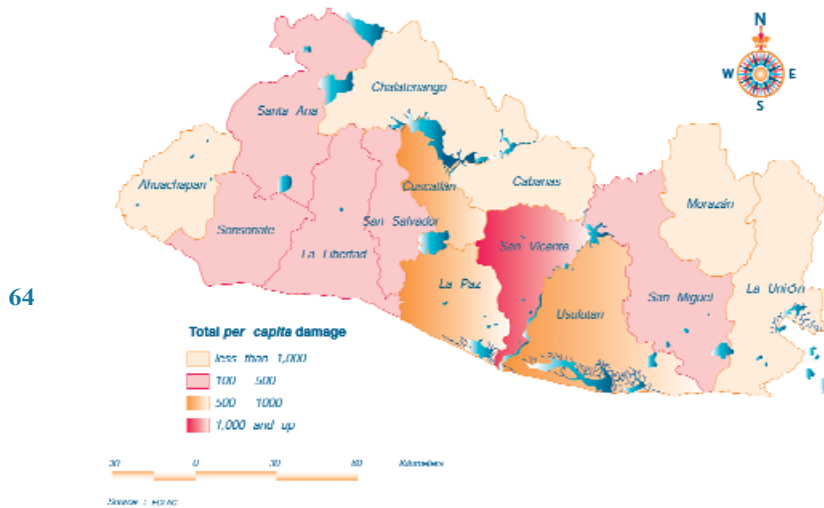
The preceding table shows that damages were most concentrated in the departments of San Vicente, La Paz and Cuscatlán, whose inhabitants sustained losses of between 1 500 dollars and 700 dollars, undoubtedly a very high percentage of their total assets. Inhabitants of the departments of Usulután, La Libertad and Sonsonate followed, in decreasing order of damage (see Table B and Map 1).

The geographic distribution of damage per inhabitant has both positive and negative implications. Most of the damage was sustained by the country's relatively more developed areas, which generally enjoy a greater recovery capacity than does the country's poorest departments (Cabañas, Morazán, Ahuachapán and La Unión). In other words, losses in human development did not greatly affect those departments where poverty is greatest (see Map 2).

Furthermore, reconstruction provides an opportunity to introduce mitigation measures that can include the provisioning of damage victims with housing and a means of production and income that is less prone to damage from future disasters.

⁵ United Nations Development Program (UNDP), Report on Human Development in El Salvador, San Salvador, 2001.

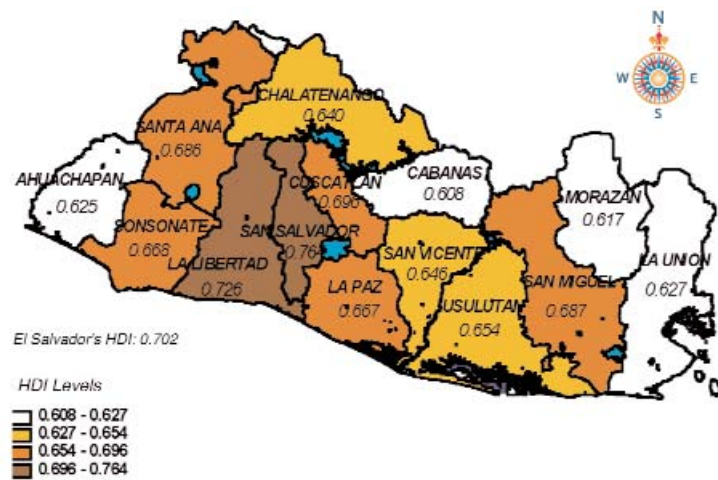
Map 1
GEOGRAPHICAL DISTRIBUTION OF DAMAGE CAUSED BY THE JANUARY
AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR
(Per capita loss in US per inhabitant)



We should note two negative aspects. First, the modest progress the country achieved in the recent past in human development indices has been erased in the departments most affected by the earthquakes. To put it differently, the geographical distribution of poverty has been modified by the disaster, with human development indices experiencing significant declines in the most affected departments. The new human development map for 2001 shows that the disaster pushed San Vicente, La Paz and Usulután to join Cabañas, Morazán, Ahuachapán and La Unión in the country's lowest human development index category (see Map 3). Second, financial resources for reconstruction will have to be concentrated on the most affected departments, coinciding at least partly with areas where the greatest development investments are being made at the present time. This would entail a setback for poverty eradication in other relatively less developed regions.

Map 2

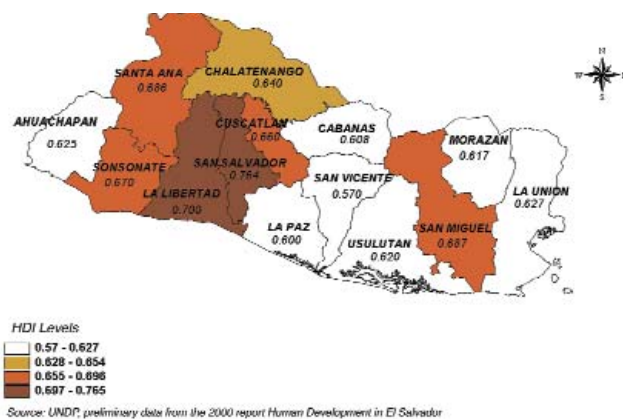
IMPACT OF JANUARY 13, 2001, EARTHQUAKE: SPATIAL DISTRIBUTION ON THE HUMAN DEVELOPMENT INDEX BEFORE THE EARTHQUAKES



Source: UNDP, preliminary data from the 2000 report Human Development in El Salvador

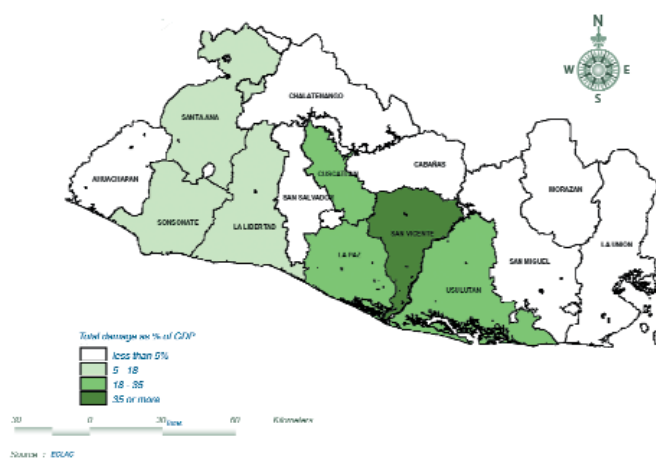
The magnitude of damage –expressed as total damage as a percentage of GDP in the affected regions– was most severe in the departments of San Vicente (57%), La Paz (31%), Cuscatlán (22%) and Usulután (19%) (see Table B and Map 4) During a scant two minutes, the earthquakes caused the loss of a considerable portion of the annual GDP of these departments.

Map 3
IMPACT OF JANUARY 13, 2001, EARTHQUAKE: SPATIAL DISTRIBUTION OF
THE HUMAN DEVELOPMENT INDEX (DHI) AFTER THE EARTHQUAKES

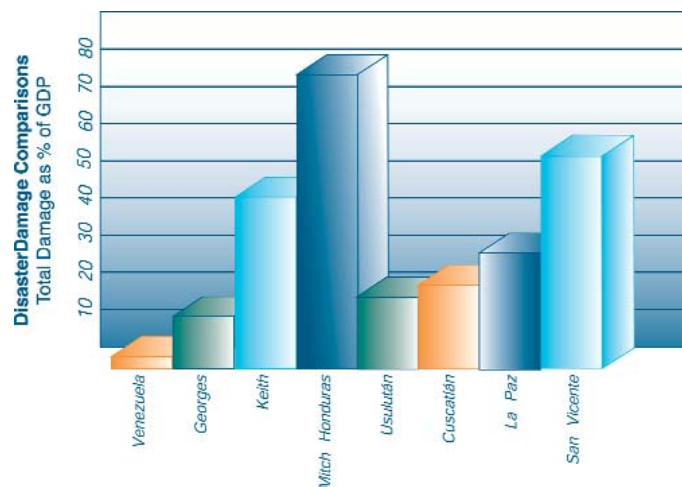


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Map 4
GEOGRAPHICAL DISTRIBUTION OF DAMAGES CAUSED BY THE JANUARY
AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR



As the following figure indicates, the loss to GDP experienced in the hardest hit department (San Vicente) was greater than that registered in Venezuela from the floods of late 1999 or in the Dominican Republic in 1998 from hurricane Georges, and it is surpassed only by hurricanes Mitch in Honduras (1998) and Keith in Belize (2000).



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By analyzing the absolute and relative earthquake-damage figures, we can identify several special disaster characteristics:

- A relatively high amount of damage, two-thirds of which corresponds to the private sector;
- Disruption and destruction of the highway transport infrastructure, thereby significantly increasing operational costs;
- Destruction or significant damage to housing and human settlements, especially in small towns and rural areas, thus aggravating existing deficits;
- Destruction or significant damage to education and health services, eroding the country's development efforts in these sectors;
- Damage to the production of micro, small, and medium-sized agricultural, industrial and commercial enterprises, while large-scale businesses in those same sectors were relatively unharmed;
- Significant damage to the environment, with considerable loss of land due to landslides and numerous hillsides that became unstable;
- A considerable concentration of damage in some departments, principally in the central part of the country;
- Significant losses in various departments, whether measured in per capita terms or in terms of the loss as a percentage of departmental GDP; and
- A reshaping of the poverty map, with several departments falling into the lowest human development index category.

However, the damage described above should also be considered within different contexts. In the first place, the property that was destroyed represents more than 40% of the country's gross annual formation of fixed capital, which provides an idea of the efforts that will be required for its replacement. Moreover, replacement costs will be notably higher than the value of the destroyed assets at the time of the disaster and are estimated at no less than 1.94 billion dollars. Although some of the construction industry's capacity was idle at the time of the disaster, its capacity is limited. We estimate that it will take between four and five years to replace all lost assets, and the population will have to endure significantly lower living conditions throughout that period.

In the second place, damage to transportation infrastructure is increasing cargo and commuter travel times, the additional costs of which are estimated at around 358 million dollars. Said costs will eventually have to be absorbed by the users, with the corresponding impact on the cost-of-living index. Similarly, despite emergency assistance received from the international community, the unforeseen costs incurred by the government both in the emergency and in reconstruction will result in increased fiscal deficits.

68 In the third place, production losses represent less than 3% of the country's exports, which might give the impression that the country's production capacity is virtually intact. Nonetheless, a good part of lost production is that of micro and small enterprises, earmarked for domestic consumption. Apart from a loss of income for those population sectors, this might result in shortages of various products on the domestic market, which would have to be imported.

In the fourth place, some of the damages caused by the disaster that occurred in El Salvador affect Central America as a whole, thus making this a subregional tragedy. With some parts of the Pan-American Highway left impassable, cargo and commuter traffic must take longer alternate routes, resulting in delays and increased transport costs for intra-regional trade. In addition, foreign tourists canceled reservations throughout Central America in the erroneous belief that damages widespread. Finally, the regional transformation and modernization strategy that the Central American countries have presented to the international community with the purpose of seeking partners to combat poverty will have to be modified to assign a greater priority to disaster vulnerability and disaster impact reduction so that Central America does not become less attractive to foreign investors.⁶

⁶ See Jovel, Roberto, et al., *Transformation and Modernisation of Central America in the XXI Century*, General Secretariat of the Central American Integration System (SG-SICA), San Salvador, January 2001.

IV. MACROECONOMIC EFFECTS OF DAMAGE

This chapter deals with the estimation of the quantifiable effects of the disaster on the main macroeconomic variables and aggregates (GDP, national income, investment and gross capital formation) and on the fundamental economic gaps (balance of payments, balance of public finances and inflation). The impacts will be measured in the short term (in the year or cycle in which the disaster occurs) and in the medium term (a period to be determined case by case according to the magnitude of the damage and the estimated time needed for a return to “normal” conditions). The macroeconomist will elaborate this chapter on the basis of the reports prepared by the sectoral experts. An accompanying task is to verify the consistency of different estimates by comparing the evolution of macroeconomic variables with that obtained by piecing together sectoral, regional or partial information. The macroeconomist should also form a view of the economic performance and the behavior of the main aggregates expected prior to the disaster. Finally, and most important, the macroeconomic assessment provides a basis on which to estimate the financial and technical cooperation that the international community is expected to contribute during the rehabilitation and reconstruction processes. This chapter contains five sections. The first provides a basic understanding of the steps involved in the macroeconomic assessment of the disaster damage. The second describes the functions of the macroeconomist. Section three refers to the establishment of the baseline, that is the pre-disaster situation and the performance expected during the year of the disaster in the absence of it. Section four deals with the assessment of the situation following the disaster. The last section details the general economic effects, the effects on economic growth and income and those on the fiscal and external accounts. For the situation following the disaster, the use of future reconstruction scenarios is introduced based on the capacity of the economy to absorb external resources and its project delivery capacity.

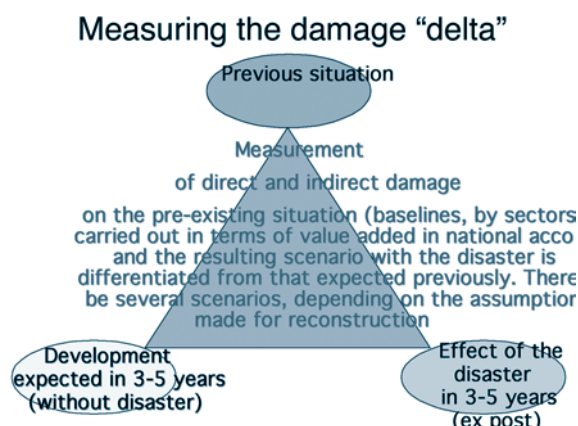
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1. Macroeconomic assessment

The macroeconomic assessment should provide a summary of the damage that offers an overview of the full magnitude of the disaster’s socio-economic impact, both for the country’s economic development as a whole and for each of its main variables.¹ It should determine and specify the sectors or areas in which the effects were most severe and the period of time for which they will continue to be felt. Consequently, it should include, not only the disaster’s effects on the economic growth rate, income, the external sector, public finances, employment, price levels and inflation, but also possible damage to natural resource endowments.

¹ This summary must be presented in a uniform and comparable manner (in the same currency units). It must take into account the possibility that a disaster’s impacts might produce net benefits to society, rather than harm or loss. If such benefits are considered significant, their value should be calculated and subtracted from total estimated damage.

The overall assessment essentially measures a “delta” value, that is, the difference between the situation expected in the period before the disaster happened and the situation that the affected country or region is expected to experience as a result of the direct and indirect damage (see the following chart).



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There may be more than one ex - post disaster effects scenario, and several post-disaster alternatives may be identified according to the local capacity for recovery; the amounts of external assistance received; the overall macroeconomic, fiscal and commercial goals set in pre-disaster programmes; the developing country's capacity to carry the debt required by the process; and any commitments that it might have with international financial institutions.

2. The functions of the macroeconomist and the preparation of the assessment

The chapter written by the macroeconomist will normally be based on the reports prepared by the sectoral specialists. Nevertheless, she or he must also work in the disaster area to gather data (sectoral, regional data) and assessments related to the disaster's macroeconomic effects. To this end, he or she should contact the macroeconomists at the ministries or government bureaus with economic functions and the financial, tax and national planning authorities. He or she should also request relevant information from academics and specialized independent analysts. When the data is vague and unreliable, the macroeconomist must rely on his or her judgment to arrive at an estimate and choose the sources for his or her figures and estimations.

Discrepancies and consistency problems are likely to arise because the data gathered comes from different sources and may be expressed in different economic units. For example, discrepancies may arise between public sector figures for national accounts data and the balance of payments. To overcome these difficulties, the macroeconomist must establish an audit trail.

An audit trail provides detailed information on the nature of the damage, its incidence and the estimated value of the damage. It is part of a meticulous approach to deriving estimates that allows for the simplification of tasks and the verification of the estimates should a figure be challenged. It includes the adoption of alternative methods for estimating the value of the damage, and it uses objective and precise criteria as a basis for the definition and adoption of decisions and priorities that will guide the rehabilitation and reconstruction programs. The audit trail should also ensure that there is no double accounting in the sectoral assessments, i.e. that effects in one sector that also have an effect on another should not be counted in both. For example, damage to rural roads will have to be clearly distinguished in the farming sector to ensure that it is not duplicated in the assessment made by the transportation and communications sector.

Quick rules of thumb that allow one to check the consistency of macroeconomic data are to use fiscal statistics to estimate government consumption in the national accounts; to review data on exports and imports from the national accounts to make it compatible with the balance of payments; to check the quality of the investment data; to compare the growth of nominal GDP with the growth rate of financial assets; to compare consumption and receipts from domestic taxes; and to compare GDP growth and imports.

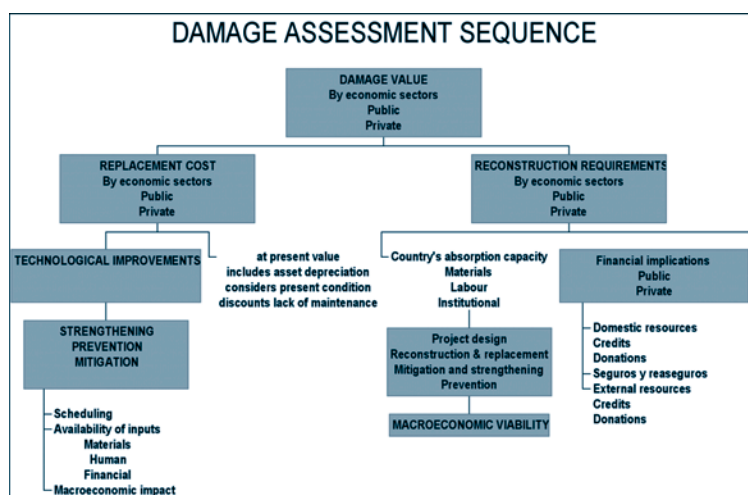
The assessment report normally includes an introduction with a brief description of the phenomenon's characteristics and the magnitude of its impact. The macroeconomist also plays an important role in the preparation of the introduction.

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A general recommendation is that direct damage be consolidated after it has been quantified in terms of physical magnitudes and that the macroeconomist analyze the criteria and prices used for setting the monetary value. This will make it possible, where necessary (especially in countries with high inflation), to make assessments at replacement values (or to adjust those that have already been made at purchase cost so that they are shown at replacement value). This is essential for determining the financial requirements of restoring the destroyed or damaged assets.²

The following chart illustrates the assessment sequence.

² The introductory chapter to this manual contains the criteria for assessing direct damage, as well as a discussion of the advantages and disadvantages of using purchase versus replacement costs. Some flexibility is called for. It is sometimes useful to show both, since one indicates the cost of the loss and the other the replacement value, which takes into account any technological improvement thought desirable when replacing the destroyed assets. Furthermore, since the reconstruction process should not recreate the prior vulnerability, which was often the cause of the seriousness or magnitude of the damage, the reconstruction value will include elements of reinforcement and improvement above and beyond the replacement value.



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The overall assessment should show the net results, that, is the difference between the negative and positive effects. A recovery in the construction sector, for example, is a phenomenon that is noticed relatively soon and can, to some extent, counteract the fall in the levels of activity forecast for most production sectors.

Another of the basic aims that should guide the work of the macroeconomist in the field is to form his or her own view on the economic performance forecast before the disaster occurred and on the way in which that performance would have been reflected in the major aggregates, both for the year in which the disaster occurred and for the following year or years.

The macroeconomist is therefore responsible for compiling and consolidating data on the impacts in the different sectors. In addition to the summary of direct damage (to capital) and indirect damage (the flows which will cease to exist) mentioned in the preceding paragraph, the macroeconomist should included an estimate of the economy's financial requirements and the financial and technical aid expected from the international community during the restoration and reconstruction process. That process normally runs for two years, but if the impact is great, it may be extended to as many as five.

The macroeconomic analysis may be called by different names, such as "effects on economic development" or "the phenomenon's repercussions on the economy". Where appropriate, the expression "in the short term" or "in the medium and short term" may be included, depending on how far into the future the effects of the disaster are projected. Such projections are generally limited to a maximum of five years, although destroyed urban service infrastructure, farmland, woodlands and the environment can take longer to replace. Similarly, the investments needed to replace production capacity and certain plantations can take more than five years to mature. These factors should be reflected in the report.

3. The situation before the disaster

As already mentioned, one of the macroeconomist's tasks will be to obtain a comprehensive understanding of pre-disaster economic trends, including its main problems, and the salient features of the economic policy that was being implemented. This background information is necessary for understanding the phenomenon's effects on the country's economy and the key areas of its economic policy, as well as the new challenges being set for the economy. Central banks, the country's economic, tax or finance ministries and its departments or ministries of planning, together with international financial bodies and ECLAC itself, prepare annual reports or have the information needed to provide an understanding of the topic.

Familiarity with the pre-existing situation can only be obtained by identifying the baselines on which the country's economy functions: those elements which are central to the economy's development -its engines of growth and the constraints imposed by the present development model (without assessing or making value judgments on it). It is also necessary to identify the most significant features of the situation prior to the disaster: the part of the cycle in which the event occurred; the seasonal nature of the activities in the country and its main sectors; and its capacity for risk exposure and for responding to external conflicts, including its ability to carry debt, the amount and importance of domestic savings and the strength and importance of flows of foreign direct investment.

This involves obtaining macroeconomic databases from the national authorities, academics and the country's economic advisors (establishing whether there are any econometric models for the economy and any input-output tables or tables of weights for intersectoral linkages). These sources can help the macroeconomist understand the estimates or projections for the situation expected before the disaster, whether scenarios or short- or medium-term projections. On the basis of frequently sketchy information and interviews, a projection should be prepared of economic growth expected before the disaster occurred and how this would have been reflected in the main aggregates: economic growth, inflation, exports, imports, balance of payments, external debt and so on. This preliminary projection will be of great assistance not only for the macroeconomist's own work, but also for that of the other members of the assessment team.

The following are usually among the most important information sources for assessing these tendencies: projections of economic growth for the year (sometimes half-yearly or even quarterly projections are prepared by planning offices or ministries or by central banks); the fiscal budget adopted and budget estimates for the following months made prior to the occurrence of the natural disaster (Ministry of Finance); and other macroeconomic statistics that are generally compiled by Institutes of Statistics; including crop growth index, trends in the manufacturing industry, monthly inflation trends and urban unemployment surveys. By extrapolating on the trends shown by these statistics during the months for which they are available, the macroeconomist will be able to estimate what annual performance would have been had the disaster not occurred.

It is more difficult for the macroeconomist to obtain global assessments of how the economy is developing in the affected area or region, since planning ministries, regional development corporations and state or provincial governments have only very recently begun to implement statistical programmes at the regional level. Naturally, if this type of information were available, it would greatly help the macroeconomist to describe the situation and the disaster area's economic outlook.

It is necessary to analyze trends in the external sector's main aggregates, namely, exports, imports, external financing, levels of international reserves and external debts. Trends in the prices and supply of the chief export products must also be taken into account when projecting the level of exports prior to the disaster. The estimated cost of servicing the debt is another important element, since the feasibility of making payments must be considered in the light of new post-disaster financial conditions and requirements.

This is also the case with other major macroeconomic aggregates: public finances (including the foreseeable deficit before the disaster occurred) and trends in the consumer price index and employment are among the most important.

74 The projections for the disaster period and for one or two years (there may be more than one pre-disaster scenario) for the main macroeconomic variables should be used to prepare a GDP series at current prices, forecasting development for at least five years from the disaster period. A constant price series (with the base year used by the country and expressed in the local currency and in dollars) is also required for the same variables. In both cases, macroeconomic data from the assessments made by international bodies and especially by ECLAC itself should be compiled before the mission in order to identify the intertemporal comparisons needed.

Finally, the exchange rate to be used for the assessment should be set. In the case of sudden events, the exchange rate for the appropriate period (whether a quarter, month, week or day) should be established; for longer-lasting events (droughts or disasters that last for several months, such as El Niño), an average for the event's duration should be determined.

4. The performance observed after the disaster

The disaster will affect the different sectors in varying degrees and will thus be reflected in the macroeconomic performance of the economy as a whole. The following table illustrates the potential impact –and possible timeframe– of an event's consequences.

Table 1
ECONOMIC IMPACTS FOLLOWING A NATURAL DISASTER ON A SMALLER ECONOMY

Economic impacts following a natural disaster on a smaller economy			
Variable	Year of event	Year after	Subsequent years
GDP	Immediate drop in GDP growth	Rise in GDP growth from reconstruction	Slow down in second and third year
Exports of goods	Reduction in the rate of growth	Return to previous levels	Continuation of year after
Imports of goods	Considerable increase in rate of growth	Return to pre-disaster level	Further drop, possibly caused by reduced incomes
Tourist arrivals	Considerable drop	Some recovery	Recovery continued
Cruise ship arrival	Considerable drop		
External debt	Increase in rate of growth	Drop of the rate of increase to below pre-disaster levels	

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The role of the macroeconomist and of the sectoral specialists is preeminent here. The purpose is to identify actions and events occurring during the emergency that have an impact on the economy's aggregates: emergency imports of food, medicines and other essential goods; the magnitude of the aid donated in solidarity by the international, local and national communities; state expenditure (at the national and local levels) to combat the disaster,³ and expenditure incurred by the private sector, either in support of the victims or to provide post-disaster goods and services until essential services are restored. This is particularly important with regard to public services (drinking water, electricity, telecommunications and telephone services), especially when, as is increasingly the case.

Similarly, with support from the sectoral specialists, the macroeconomist should attempt to quantify the effects of the disaster on the education, health and other public infrastructures, many of which, if they have not been catastrophically damaged, are used as shelters and centers for storing and distributing aid. These expenditures must be specifically accounted for, in addition to any damage suffered by the health and education sectors themselves.

³ Including military expenditure, such as, transportation, personnel mobilization and space at army premises; use of installations, vehicles and personnel belonging to the different agencies mobilized by the official emergency response bodies (committees, national and local emergency offices, etc.); and resources from national disaster funds, when these form part of the state's budget.

During the event, resources are received not only in the form of altruistic aid (whether requested or not), but also from other sources. Registers exist of aid agencies, such as the Red Cross and other international bodies. The United Nations also publishes regular bulletins with information about the progress of the disaster, emergency needs and very short-term consequences. At the request of the affected country, a consolidated request for support is prepared. All such international information can be found at www.reliefweb.org, a Web site that should be consulted before the assessment is begun. As well as making it possible to complete the data needed to identify the expenditure incurred during the emergency (which has to be shown in the consolidated summary of damage), the systemization of this information will also facilitate its inclusion when measuring the disaster's impact on external variables, public finances and the currency.

a) General economic effects

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The idea under this heading is, above all, to present a summarized appreciation of the disaster's economic repercussions throughout the economy. The specialist should gather data on the repercussions for capital assets (direct damage) and for the flows that will cease to exist (indirect damage), as well as on the secondary effects on the main macroeconomic variables mentioned. This mainly consists of a summary and analysis of the table data, which shows damage to physical infrastructure and natural resources, as well as to the production of goods and services that will cease to exist. It also includes increased import requirements resulting from the disaster. It usually covers a period of two years, but can be extended to five if the disaster's magnitude so merits. If relevant, it includes alternative scenarios of later developments and specifies the assumptions underlying each one.

This analysis is essential for designing restoration and reconstruction programmes and for orientating any international aid that might be needed. To this end, it is often necessary to show amounts in domestic currency (at the prices in the period when the assessment was made) and in dollars. The text should also include a summary of the effects (with a breakdown) on economic growth, population income level, employment, inflation, exports and imports and public finances.

A summary table showing the main economic indicators and the way in which the disaster affected them supports the relevant analysis. The sectoral specialists provide the macroeconomist with their estimates of indirect damage to production and services for the present and the following year and of the implications for the external sector. This damage is assessed at current prices in the year when the disaster occurred. This information is entered in the first two columns of Table 2. The last two columns indicate the ratio of value - added to the gross value of production. In Appendix XVI, as in the previous chapters dealing with specific sectors, an example is included to illustrate the contents of the macroeconomic overall impact assessment.

Table 2

SECTOR	EXTERNAL IMPACT	MACROECONOMIC IMPLICATIONS WEIGHTED BY ECONOMETRIC MODELS AND INPUT-OUTPUT TABLES WHEN AVAILABLE	
		GROSS VALUE OF PRODUCTION	VALUE ADDED
PRODUCTION SECTORS			
Farming (including livestock, fishing, forest resources)			
Industry			
Commerce			
Services			
- Finances and banking			
- Tourism			
- Personal and other non-industrial			
INFRASTRUCTURE			
Water (drinking, irrigation, drainage, sanitation, and waste disposal)			
Energy (generation, transmission, distribution)			
- Electricity			
- Others (oil, gas, etc.)			
Transportation and communications			
SOCIAL ASPECTS			
Education			
Health			
Housing and human settlements			
Cultural heritage			
Social conditions (social fabric: employment, etc.)			
ENVIRONMENTAL ASPECTS			
TOTAL			
FISCAL IMPLICATIONS (for the public sector)			
- Income			
- Expenditure			

The cost of the impact in terms of direct and indirect damage will be assessed sector by sector by means of the assessment methods described or suggested for each sector. Available sectoral weighting methods will be applied to these values to identify delta (D), or “damage” expressed as the difference between the expected value without the disaster (Va) and the value produced by the weighted sectoral assessment (Vb).

DAMAGE “DELTA”

The difference between the expected results with and without the disaster are expressed as follows:

$D = V_a - V_b$, where V_a is the variable's initially expected condition (sectoral, weighted) and V_b is the value discounting the disaster's effect.

Direct damage shows the losses of capital assets and is calculated as follows:

$K = K_a - K_b$, which measures the loss of capital, where this is assessed from the identified direct damage, sector by sector.

The indirect effects, in terms of output/income affected by the event, is expressed as:

$DY = Y_a - Y_b$, which measures the lost output/income.

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Generally speaking, it is assumed that the capital/income-output relationship is not substantially altered by the disaster. Nevertheless, if sufficient information is available, it could be assumed that there have been changes in this relationship as a result of the disaster and the reconstruction processes. This is one of the elements that might motivate the suggestion of alternative scenarios.

b) The effects on economic growth and income

The aggregate that best reflects variations in the general level of economic activity is gross domestic product (GDP). Accordingly, the macroeconomist should estimate the disaster's effects on this variable's growth rate and the extent to which they modify the GDP forecasts made before the disaster. As stated, these estimates are generally relevant for a period of one or two years beyond the disaster year.

A clear distinction should be made between nominal and real magnitudes. GDP is generally obtained in nominal values and is transformed into a real magnitude. Thus the impact “delta” should be made in real terms (real magnitudes expressed in the prices of the base year normally used in the country) in order to obtain an appreciation of the disaster's real effects on the economic growth rate. One common problem of a statistical nature is explicitly distinguishing between the nominal and real value of the major aggregates that make up internal supply (gross domestic output by branches of activity) and demand (expenditure on public and private consumption and capital formation) at the time of the disaster occurred.

The macroeconomist must therefore consult national experts in order to select the most appropriate and reliable price index (whether the implicit price deflator of GDP, the wholesale price index or the cost of living index), so that the figures are expressed at constant values. This conversion is essential for the correct appreciation of the magnitude of the losses in GDP or income resulting from the disaster and their effect on the forecast growth rate. It is important to make clear that once this adjustment has been made, the data for the year, or for the two or more subsequent years, should be expressed, as far as possible, in constant disaster-year prices. In other words, the effect of inflation should be removed. This is important because the purpose at this point is to estimate the disaster's effects on the real growth rate.

The forecast aggregate demand and supply information obtained is to be modified according to the damage calculations supplied by the sectoral specialists, by applying these the deflators recommended by the Central Bank or corresponding economic authority.

The preceding calculation is used to make a preliminary estimate of the disaster's impact on the sector's GDP makeup. When the impact of reconstruction programmes is taken into account, the assessment might show that the disaster has a positive effect on GDP. Once the macroeconomist is in possession of the gross values of the damage obtained by the sectoral specialists, he or she must convert them to value - added so that they can be incorporated into GDP. This can be done by identifying the ratio of value-added to gross production value for all economic sectors and branches of activity. The above information is generally obtained from an input-output matrix that is recent enough for the ratios to be valid, or considering appropriate ratios.

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The projections and forecasts about post-disaster development are made first for the disaster year and then for the following year(s). The number of years to be considered will vary in accordance with the relative impact of the event given the size and level of development of the economy and the economic cycle. These projections may be made for several alternative scenarios. The assumptions applicable to each case must be specified. There is not much literature on the subject, and, to obtain an approximate estimate of the impact, it would be prudent to consider the models used by the country's analysts or by analysts at international institutions. All these models must be subject to a set of endogenous and exogenous variables and, for the purpose of simplification, certain assumptions must be made for each case. The methodological and taxonomic development of each model is not shown here. This task has to be carried out on a case-by-case basis in order to decide which type of model or models are to be employed.

i) **The measurement of GDP.** Generally, GDP data is obtained on the basis of real sectoral data. In some cases, the distinction should be made between GDP at market prices and at factor costs. GDP data is sometimes obtained at factor costs, while the macroeconomists needs GDP at market prices. The relationship between value - added and final demand is shown in the following table.

Gross domestic product as net contribution to income	Gross domestic product as net final demand
<ul style="list-style-type: none"> - Gross value - added to basic prices <ul style="list-style-type: none"> o Remuneration paid to wage earners o Other taxes less production subsidies o Fixed capital consumed o Surplus of exploitation/mixed income - Taxes less production subsidies 	<ul style="list-style-type: none"> - Household final consumption expenditure - Final consumption expenditure by non-profit institutions serving households (individual) - Government's final consumption expenditure <ul style="list-style-type: none"> o Collective o Individual - Gross fixed capital formation <ul style="list-style-type: none"> o Gross fixed capital formation o Variations in stock levels o Purchases minus disposal of valuable objects - FOB exports - Minus FOB imports

Alternative ways to calculate GDP

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- As the sum of value - added (the production approach) - GDP estimated at consumer purchaser's prices (GDPbp). This is the sum of gross production in each sector at producer prices (GPpp) minus each industry's intermediate consumption at purchaser's prices (ICbp), plus customs duties and other import taxes (Im):

$$\text{GDP} = \text{total industrial production at basic prices}$$

$$\text{GDP} = \text{PBpp} - \text{ICbp} + \text{Im}$$

This approach makes it possible to calculate the value - added to each industry's basic price by subtracting each industry's intermediate consumption at purchaser's price from its production at basic price.

- As the sum of primary incomes (the income approach). With this approach, GDPbp is equal to the sum of employees' remunerations (Er), indirect taxes net of subsidies (Tin), fixed capital consumed (CKF), net exploitation surplus (NES) and customs duties and other import taxes (Im):

$$\text{GDPbp} = \text{Er} + \text{Tin} + \text{CKF} + \text{NES} + \text{Im}$$

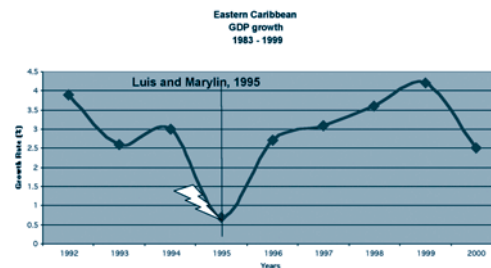
- As net final demand (the expenditure approach). In this process GDPbp is equal to the sum of final consumption (FC), gross fixed capital formation (GFKF), variation in stock levels (E) and exports (X), minus imports:

$$\text{GDPbp} = \text{FC} + \text{GFKF} + \text{E} + \text{X} - \text{M}$$

- The commodity flow approach. The national accounts system combines three approaches (production, income and expenditure) to calculate national accounts statistics. Since it balances the supply and use of each output by means of supply and use tables, it is possible to make a uniform crosscheck at a very detailed level to ensure that the figures are consistent.

Therefore, the input-output matrix preparation methodology can be used for calculating GDP at purchaser's prices (GDP_{bp}) and measuring it either as the sum of value - added or of primary incomes, or as net final demand. With the assistance of the input-output tables or the sectoral weightings, it is possible to identify the way in which damage in one sector is reflected in others. Losses are accounted for at replacement cost and the damage scenario is defined. Changes in basic balances -external sector, fiscal deficit, internal balance (prices, exchange rate, etc.- should be highlighted.

The past performance of economies following a major disaster are exemplified by the situation experienced in the Caribbean after two major hurricanes, Luis and Marilyn, as is illustrated by the following graph.



Source: Eastern Caribbean Central Bank

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ii) **The use of several future scenarios.** The first scenario (quantification and impact of the event without taking later reconstruction activities into account) serves as a basis for alternative reconstruction scenarios. These scenarios are based not on replacement values, but on reconstruction costs, the emergency reconstruction priorities sector by sector and the reconstruction strategies that begin to emerge in the weeks following the disaster.

The various scenarios should specify the assumptions made about two core elements: the economy's capacity to absorb external resources and its project delivery capacity. These scenarios should also include assessments of the way that key economic variables will behave in the event of a significant increase or diversion of resources for reconstruction taking into account interest rates, debt capacity and the availability of production inputs and means (raw materials, capital goods, internal savings, labor, etc.).

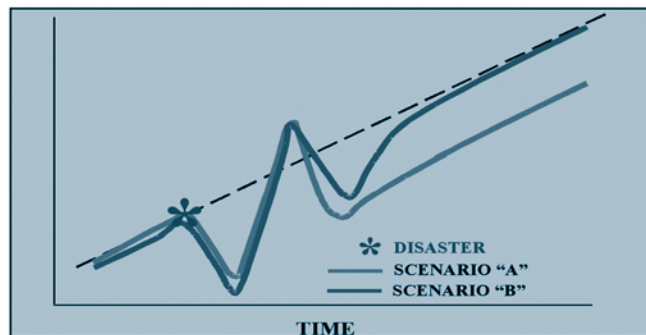
The effect on income refers to connections that might be established with the impact on employment. This is extremely important for calculating the impact of a disaster that slows or closes down income - generating activities. The estimate of the impact on income also includes an assessment of the disaster's effect on inflation and the available sources of supply. The calculation of the effects on the population's income is another way of analyzing the problem of the disaster's consequences on the level of activity (and for that reason it should not, of course, be added to them). It is sometimes useful to singularize effects when they encompass a defined stratum of the population (especially the lowest deciles), in order to facilitate the design of reconstruction-related occupational absorption programmes, whether in rural or urban areas. Clearly, these assessments will be closely related to those made about the disaster's effects on employment. These phenomena sometimes affect the population's real income if inflexible supply, caused by temporary interruption to the supply channels, exacerbates inflation. The example that accompanies this chapter (taken from the assessment of the macroeconomic impact of the El Salvador earthquakes in 2001) shows the type of analysis and macroeconomic assessment results expected. The following table and figures illustrate the way in which the results should be presented at the end of the exercise.

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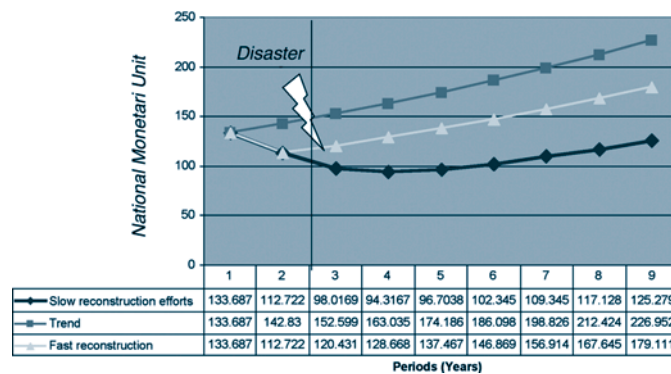
MACRO / GLOBAL IMPACT (CURRENT VALUE AND CONSTANT VALUE)	EX ANTE SITUATION (CURRENT PERIOD)	EX POST SITUATION (CURRENT PERIOD)	SHORT- AND MEDIUM- TERM PROJECTIONS (INCLUDING ALTERNATE SCENARIOS)
1. GDP			
EXTERNAL BALANCE			
- Exports			
- Imports			
A - BALANCE OF TRADE			
B - CURRENT BALANCE AND CAPITAL ACCOUNT			
- Net credits (including service and repayment)			
- Net donations			
- Net private transfers			
- Other income (payments from insurers and reinsurers)			
2. FISCAL BALANCE			
- Income			
- Expenditure			
3. CAPITAL ACCOUNT			
- Gross capital formation			
- Domestic investment			
- Foreign direct investment			

Based on a consistency model, different reconstruction scenarios may be estimated. The model that produced the second figure is based on particular features of a smaller economy and on the empirical evidence available for smaller economies before and after a disaster.

THE EFFECT OF DISTASTERS ON THE GROWTH OF A NATIONAL ECONOMY



NATIONAL INCOME BEFORE AND AFTER A DISASTER: SLOW OR FASTERCOVERY ADJUSTMENT AS COMPARED TO TREND



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c) Effects on the external sector and the balance of payments

When making their assessments, the sectoral specialists will have included among the disaster's secondary effects those that affect the current account of the balance of payments and, where relevant, the external financial requirements for the reconstruction process.

The macroeconomist will need to have estimates of the balance of payments for the economy as a whole, as well as a projection for the disaster year (and, if possible, for the following year, too). This information must be supplemented with information on other external-sector basic magnitudes (e.g., the total amount of external debt, the effect of debt servicing and the level of international monetary reserves).

The data required for estimating the effects of the disaster on the balance of payments are as follows: a pre-disaster estimate of the balance of payments for the year in which the disaster occurs; and the balance - of - payment accounts for the preceding five years, using the most detailed data possible (i.e., IMF, Fifth Manual). The balance of payments comprises three components: flows of goods and services in and out of the country; unilateral transfers that are the counterpart of real resources or financial claims that are provided or received; and changes in resident's claims on, and liabilities to, non-residents that arise from economic transactions.

Possible effects on the balance of payments

a) Flows of goods and services

Decrease in export merchandise (a result of the destruction of output and capacity or of diversion to the internal market).

Decrease in service earnings, which arises out of losses to the merchant fleet, tourism and other infrastructure.

Increase in imports that are indispensable during the restoration phase (fuel; foodstuffs to replace lost harvests and production of staple food; additional inputs).

Decrease in import value due to tariff reduction.

Disaster related insurance and re-insurance.

b) Unilateral transfers

Unilateral transfers received from the rest of the world will increase (donations and grants; remittances).

Unilateral transfers provided to the rest of the world will decrease (profit and interest repatriation).

c) Changes in resident's claims

Changes in resident's claims should be estimated on the basis of the need for medium - and long - term external financing of restoration and reconstruction during the two years following the event.

The expert should also consider in the calculation additional external financing needed to confront a possible worsening of the current account deficit. The performance of the balance of payments for Dominica (in US dollars) following hurricanes Luis and Marilyn (1995) illustrates such an assessment.

Dominica: Balance of payments (US dollars. Millions) 1993-1997					
	1993	1994	1995	1996	1997
Goods	-118	-129	-143	-129	137
Services	48.9	36.4	34.5	64.9	84.0
Income	-17.3	-29.9	36.0	-53.2	-46.5
Transfers	23.5	19.1	21.2	27.5	28.3
Capital transfers	26.3	23.2	52.3	57.4	60.8
Financial account	53.9	80.5	78.9	26.6	14.2
Foreign direct investment	35.7	61.1	146.1	48.1	57.0

Source: Eastern Caribbean Central Bank

d) The effect on public finances

A natural disaster affects the budget. The budget is a financial programming exercise projecting how the government plans to spend revenue. It presents certain expected levels of receipts and certain expected levels of expenditures. Public sector operations may be reported on a cash flow or accrual basis. Central government revenues should be shown on a cash basis. Revenues on an accrual basis may include commitments by their parties that cannot be honored.

The presentation of fiscal accounts on an accrual basis depends on the need to reconcile fiscal with other financial and economic variables, the importance of the floating debt as a source of finance and the availability of data. Public sector operations are carried out in the context of a fiscal year. The fiscal year does not necessarily coincide with the calendar year. Adjustments are needed to make fiscal figures compatible with other figures such as the national accounts.

Possible budgetary effects due to the disaster include the following:

Reduction in current revenues due to decreases in tax revenues: the tax base, tax rates, tax holidays (reductions in import duties) and non-tax revenues;

Reduction in capital revenues due to destruction and damage;

Variations (probable increase) in current (operating) expenditures: increases in operating outlays, increases in transfers and decreases of interest on public debt; and

Increase in capital expenditures: increase in direct investment, capital transfers and financial operations.

The financial impact of the disaster can be analyzed by rearranging the fiscal components in a presentation that shows the gap between central government operations and their financing. It is important to take into account the influence of the rest of the general government accounts and in particular that of state enterprises on the budget. The relations between state enterprises and the central budget are captured in current expenditures under transfers. Enterprises can be classified into those engaged in production; in providing certain services; in marketing commodities; and in producing, importing, and refining petroleum products.

As an example of such a budget impact on a very small economy, Antigua and Barbuda reported increased import tax revenues following hurricanes Luis and Marilyn in 1995 despite a reduction in import tariffs.

Antigua and Barbuda: Central Government Budget Balances (EC Dollars) Millions, 1993 - 1997					
	1993	1994	1995	1996	1997
Tax revenue	255.0	281.0	283.0	323.0	327.0
Domestic taxes	44.8	52.0	53.3	59.9	63.4
International trade taxes	140.5	156.2	160.6	181.6	187.5
Import duties	44.0	47.1	46.0	54.6	56.8
Current expenditure	274.4	275.4	290.6	314.6	324.3
Capital expenditure	2.4	2.8	4.2	5.0	3.7

e) Employment

- 86 The reports on the social and economic sectors should include estimates that make it possible to appreciate the overall effects on the level of employment derived from: the effects of the destruction of production capacity or social infrastructure, and from the occupational requirements created during the emergency and the rehabilitation process. These effects on employment not only have implications for household incomes and national output, but they increasingly affect people's mobility and migratory flows, both within the country (between the most and least affected regions) and to neighboring and more distant nations. Such shifts often have significant social and political implications.

f) Prices and inflation

Inflation data should be readily available from the Central Bank on a monthly or at least quarterly basis. It is a key variable for the IMF and for countries that have programmes with the IMF. However, price surveys leading to the construction of a price index are generally carried out in urban areas. Therefore, the analyst may be confronted with a paucity of pricing data for the countryside when assessing a natural disaster that has affected a sector such as agriculture.

Although the macroeconomist cannot be expected to measure the general levels of inflation before and after the disaster, he or she should at least express an opinion (based on the sectoral analyses) about the effect that supply constraints (due to destruction of crops, manufactured goods, trading channels, transportation routes, etc.) could have on the price of particular goods and services that will be supplied by alternative means. An assessment of the influence of these variations on general price levels and on relative prices must be made and included in the description of the general effects of the disaster.

g) The use of models

As already mentioned, the models to be used will preferably be those generally employed by analysts in the country in question. Examples will now be given of two generic models and the tools that are needed when adapting these models to specific cases. The behavior of investment deserves a separate discussion. The effects on investment are not clear from the damage assessment; they will vary according to the availability and quality (amount, terms and conditions, internal/external mix and public/private participation) of resources for the reconstruction process. The use of models allows for the introduction of different scenarios and constraints. In Appendix XVII, two models are briefly described as an illustration of how they can be useful for measuring short- and medium-term impact and designing reconstruction strategies.

Models are alternative methods that macroeconomists can use to process and analyze the information received from the sectoral specialists and the country's economic authorities. Past experience of disaster assessments suggests that estimates of impact on GDP and on the GDP growth rate are made by positing different scenarios, not just one unvarying course of action. It should be remembered that estimates of impact on the GDP growth rate made using the input-output matrix and the GOV and VA ratios are only approximations of reality and that in practice, many countries in the region lack an up-to-date or relatively recent input-output matrix. Therefore, estimates made using this instrument can be unreliable or fail to reflect the magnitude of sectoral impacts.

From the point of view of macroeconomic policy, the key question is this: How much money does the government need to finance the reconstruction costs, and how quickly can it obtain it while remaining within the framework of sustainable fiscal policy? At this point in the assessment it is important to identify the underlying public sector deficit, that is the deficit excluding reconstruction costs. The next step is to determine how the underlying deficit was expected to be financed: for example, by loans from multilateral institutions, by issuing bonds, or both. If loans are obtained, information on the maturity, grace periods and interest rate (generally expressed in terms of LIBOR rates plus x basis points) should be obtained from the country's authorities, and a medium- and long-term debt plan should be drawn up. Once this information has been obtained, two scenario modes can be proposed:

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a. Probable financing structure and

b. An occurrence probability associated with each financing structure. With the first mode, there can be as many scenarios as there are financing structures defined. To simplify matters, no more than three scenarios should be used, each one set out in roughly the following way:

Scenario A (pessimistic): this assumes that the government contracts loans for the amount needed to repair the damage and pay the estimated replacement costs over a period of several years (e.g., five) without overheating the economy or throwing the system out of balance. The related expenditure is also distributed over the same period because of the limits on the economy's absorptive capacity. It is assumed that the loans will have a long-term maturity period (e.g., 20 years), a grace period of several years (e.g., five) an interest rate equivalent to the LIBOR plus a moderate number of basis points (e.g., 150).⁴

Scenario B (probable): this assumes that the government contracts loans for the amount needed to repair the damage and pay the estimated replacement costs over the same period suggested in the previous example (five years). The disbursements of the loans contracted at the end of the disaster year are paid on the same terms as in Scenario A, but it is assumed that the financing is raised by issuing special disaster bonds with a longer maturity period (e.g., seven years) and an interest rate of LIBOR plus a sufficient number of basis points (e.g., 280) to make it an attractive investment.

Scenario C (optimistic): This assumes that the government borrows more money in order to improve and strengthen the infrastructure of the affected area by incorporating vulnerability reduction programmes in the reconstruction process. The loans are contracted on the same terms as in Scenario A.

88 With the second mode, each scenario is associated with a probability distribution that, as in the preceding mode, can be distinguished by the occurrence probability allocated to the three scenarios. An occurrence probability of 50 percent is assumed for the probable scenario and 25 percent each for the pessimistic and optimistic scenarios.

In every case, it is important to check whether the reconstruction expenditure is expected to create faster economic growth, especially if it is assumed that a good part of the additional expenditure will be reflected in the volume of imports. In short, projections should be made for the planned reconstruction period based on the total underlying deficit:

$$\text{Total underlying deficit} = \text{net financing need plus debt amortization} = \text{gross financing need minus disbursements of existing debt} = \text{fiscal financing gap}$$

The above information can be used to make a “sensitivity analysis” by distinguishing between the overall fiscal deficit in each of the proposed scenarios and the underlying position. The analysis can be extended to include public debt and debt servicing, the financial gap and the balance of payments.

⁴ The periods and the points added to the interest rate will be adapted in each case to the affected country's financial conditions and risk rating, to the magnitude of the debt and to the economy's capacity to absorb the required reconstruction.

APPENDIX XVI MACROECONOMIC EFFECTS OF THE EARTHQUAKES IN EL SALVADOR IN 2001

1. Summary of damage

Total damage is the equivalent of 12.1 percent of 2000's GDP. It is also the equivalent of 43.5 percent of exports, 29.3 percent of imports, and 42.3 percent of gross fixed capital formation. These figures highlight the challenges facing public finances and the external sector.

2. The situation before the earthquake

General features

El Salvador's GDP grew by 2 percent in 2000, marking the third consecutive year of falling growth rates.⁵ To a large extent, this performance was associated with a slack export sector, where a fall in international coffee and sugar prices combined with a rise in fuel prices to worsen the terms of trade. A slowdown was also experienced in the construction and trade sectors, as well as in agriculture for domestic consumption.

Public finances weakened in 1999; together with the external sector, this constituted the most vulnerable area of the economy. The deterioration occurred in spite of efforts to apply a conservative fiscal policy in spending, as well as measures aimed at broadening the taxpayer base and reducing tax avoidance and evasion. Some of the government's basic assumptions about the economic situation before the earthquake are shown in Table 1.

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At the close of 2000, a central government fiscal deficit of 2.3 percent of GDP was reported; this was slightly higher than in 1999. For 2001, without the effect of the earthquake, the fiscal deficit had been estimated at 2.8 percent. Had the trend in revenue collection continued, the fiscal deficit was expected to come under more pressure, largely because of the government's obligation to pay more than a billion dollars in pensions over the next five years. Income from customs duties was also expected to fall as a result of free trade agreements entered into by the country.

⁵ According to official estimates in December 2000.

Table 1

SELECTED ECONOMIC INDICATORS

	1999	2000	2001 (before the earthquake)
Targets			
Real GDP (%)	3.4	2.0	3.5 - 4.5
Inflation (%)	-1.0	4.3	2.0 - 4.0
Assumptions			
Coffee crop 1999/2000 (hundreds of millions of pounds)	3.2	-,-	-,-
Coffee crop 2000/01 (hundreds of millions of pounds)		2.9	3.2
Coffee exports (hundreds of millions of pounds)	2.5	3.1	2.6
Average price of exported coffee (dollars per 100 pounds)	99.0	96.5	75.0
Exports of goods FOB (millions of dollars)	2,500.4	2,981.9	3,603.1
Imports of goods CIF (millions of dollars)	4,119.9	4,908.1	5,782.0
External inflation (%)	2.6	3.7	2.0- 3.0

Source: El Salvador Central Reserve Bank.

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In the private sector in 2000, the highest growth was to be found in the transport and communications (6.2%), banking and insurance (5.1%) and manufacturing (4.5%) sectors. In the external sector, exports of goods and services increased by 17.3 percent and imports by 18.1 percent, taking the deficit on the trade balance of goods and services to 26 percent. The current account deficit was the equivalent of 3 percent of GDP, compared with 2 percent in 1999. Before the earthquake, it was estimated that the deficit in 2001 would be reduced to 2.5 percent, because of expected improvements in exports of maquila products (especially textiles) following the broadening of the Caribbean Basin Initiative.

Trade deficits continued to be offset by family remittances, which totaled 1.751 billion dollars in 2000. In addition, the Central Reserve Bank had amassed net international reserves of almost 1.9 billion dollars, the equivalent of four and a half months of that year's imports.

December-to-December inflation in 2000, measured by the national consumer price index (CPI), was close to 4.3 percent, reversing the previous year's -1 percent. Before the earthquake, a December-to-December inflation rate of 3 percent had been projected for 2001.

In late November 2000, the Monetary Integration Project was announced. When it came into effect on January 1, 2001, the prevailing exchange rate, which had been in effect since 1994, was set at 8.75 colóns to the dollar. Other currencies were allowed to circulate freely alongside the colón, and the dollar was made the unit of account for the financial system. Prior to the earthquake, the government had hoped that this process would promote the flow of capital and increase foreign direct investment.

It is important to emphasize that the macroeconomic mechanisms used to adjust to external shocks (e.g., the January 13 earthquake) in a dollarized scenario are totally different from those used in a national currency scenario. In the former scenario, adjustments can be made through fiscal measures and through the labor market; in the latter, it can be made by modifying the nominal exchange rate. A dollarized scenario calls for strict control of public finances, together with greater external resources and considerable flexibility in the labor market.

3. The accumulated effects of the two earthquakes: post-earthquake projections for 2001 and the following years

The assessment of the macroeconomic effects of the second earthquake for 2001 and the following years uses the estimates contained in the document on the 13 January disaster to focus on the impact on growth, inflation and the deficit, both in the current account of the balance of payments and in public finances.

Some post-earthquake projections of the most probable 2001 macroeconomic scenario measure the role of economic policy and, as a result, the future reconstruction challenge.

The earthquake's main impact on the GDP growth rate, in terms of the GDP percentile structure, was on the social (40 percent), infrastructure (32 percent) and production (20 percent) sectors. The most badly affected part of the social sector was housing. In infrastructure, roads suffered the most damage, and their restoration and reconstruction may raise the country's low level of public and private investment. In the production sectors, the greatest damage was caused to small and micro - businesses, many of which have begun to recover on their own initiative, although many others will disappear permanently or will only be revived with the assistance of directed credit programmes to provide them with working capital and inventory capital.

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Table 2 shows overall supply and demand at current prices. The post-earthquake projection column includes the increase in imports that might occur because of reconstruction work.

Table 3 shows overall supply and demand at constant 1990 prices. The projection for 2001 was estimated by the Central Reserve Bank for a pre-earthquake scenario with 4.5 percent growth in GDP. All post-earthquake estimates were made by ECLAC and show a GDP growth rate of 4 percent in the first year (2001), with stronger growth in 2002 and 2003.

In short, the conclusion is that an earthquake in a small open economy like that of El Salvador puts increased pressures on public finances, since the additional expenditure, added to import requirements (especially for construction and housing) can culminate in simultaneous internal and external deficits. These will turn the adjustment process into a cause of higher unemployment rates, unless the international community provides additional financing. Such new funding must be provided on concessionary terms to ensure that the increase in the country's foreign debt does not increase its external weakness.

When added to those contracted after the previous earthquake, the new loans provided by multilateral institutions to lessen the fiscal gap caused by the magnitude of the reconstruction expenditure (an estimated 336 million dollars for this event) a total of 1.94 billion dollars.⁶ It is considered that reconstruction will call for average annual investments of 390 million dollars over the next five years (a total of 1.9 billion dollars)

Table 2
OVERALL SUPPLY AND DEMAND AT CURRENT PRICES
(Millions of dollars)

	1999 Preliminary	2000 Projection rev. Dec.	2001 Projection pre-quake	2001 Projection post-quake	Percentage of GDP		
					2000	2001 before	2001 after
Overall demand	149,779.1	163,730.2	180,767.7	182,163.7	141.6	145.0	146.8
Consumption	104,605.4	111,988.5	121,514.9	121,503.2	96.8	97.5	97.9
Private	93,624.4	100,411.5	108,649.9	108,569.6	86.8	87.2	87.5
Public	10,981.0	11,577.0	12,865.0	12,933.6	10.0	10.3	10.4
Gross domestic investment	17,741.6	19,574.9	21,310.2	22,588.3	16.9	17.1	18.2
Fixed capital formation	17,618.9	19,436.2	21,083.3	22,406.1	16.8	16.9	18.1
Private	14,376.1	16,011.2	17,148.1	18,216.4	13.8	13.8	14.7
Public	3,242.8	3,425.0	3,935.2	4,189.8	3.0	3.2	3.4
Inventory variations	122.7	138.7	226.9	182.2	0.1	0.2	0.1
Export of goods and services	27,432.1	32,166.8	37,942.6	38,072.2	27.8	30.4	30.7
Overall supply	149,779.1	163,730.0	180,767.6	182,163.7	141.6	145.0	146.8
Imports of goods and services	40,693.6	48,062.9	56,108.5	58,108.5	41.6	45.0	46.8
Gross Domestic Product	109,085.5	115,667.1	124,659.1	124,055.2	100.0	100.0	100.0
Farming	11,725.9	11,806.7	12,414.4	12,086.2	10.2	10.0	9.7
Mining and quarrying	435.2	461.7	499.3	499.3	0.4	0.4	0.4
Manufacturing industries	24,545.9	27,092.3	29,476.9	29,412.6	23.4	23.6	23.7
Water and electricity	2,020.4	2,350.9	2,551.8	2,444.5	2.0	2.0	2.0
Construction	4,773.6	5,037.0	5,484.0	5,799.8	4.4	4.4	4.7
Commerce, hotels, and restaurants	20,740.6	21,462.6	22,857.8	22,632.3	18.6	18.3	18.2
Transportation, storage, and communications	9,209.3	9,955.6	10,858.2	10,858.2	8.6	8.7	8.8
Banking, insurance, and other financial institutions	4,606.9	4,952.7	5,417.8	5,417.8	4.3	4.3	4.4
Real estate and business services a/	4,544.3	4,704.7	5,000.9	5,050.9	4.1	4.0	4.1
Housing rentals	8,634.9	9,027.4	9,649.4	9,699.4	7.8	7.7	7.8
Community, social, personal, and domestic services b/	7,191.5	7,751.1	8,143.1	8,034.7	6.7	6.5	6.5
Government services	8,071.2	8,491.7	9,084.5	8,898.5	7.3	7.3	7.2
Minus							
Attributed banking services	4,506.6	4,845.4	5,225.4	5,225.4	4.2	4.2	4.2
Plus							
Customs duties and VAT	7,092.4	7,418.1	8,446.4	8,446.4	6.4	6.8	6.8

Source: ECLAC, preliminary estimates based on figures provided by the Central Reserve Bank.

a/ Includes leasing and use of non-residential properties; professional legal, accounting, and audit services; preparation of data, computer services, architectural services, and advertising.

b/ Includes private education and health services, entertainment services (cinema and television) and other services such as veterinary services; trade, professional, labor, and religious associations; electrical and motor vehicle repair shops.

⁶ Plus the sum of 112 million dollars needed for the reconstruction of housing whose loss was reported after 31 January, but before the second earthquake.

Table 3

OVERALL SUPPLY AND DEMANDS AT CONSTANT PRICES

	1990 Preliminary	2000 rev. Dec.	2001 Projection pre-quake	2001 Projection post-quake	Relative changes		
					2000/99	2001/00 pre-quake	2001/00 post-quake
Overall demand	84,898.5	89,439.8	96,081.2	97,100.6	5.3	7.4	8.6
Consumption	55,411.1	56,273.4	58,777.6	58,776.9	1.6	4.5	4.4
Private	50,710.6	51,557.7	53,749.1	53,720.7	1.7	4.3	4.2
Public	4,700.5	4,715.7	5,028.5	5,056.1	0.3	6.6	7.2
Gross domestic investment	10,594.8	11,149.5	11,957.8	12,630.6	5.2	7.2	13.3
Fixed capital formation	10,488.3	11,054.0	11,670.8	12,400.2	5.4	5.6	12.2
Private	8,829.3	9,421.4	9,851.4	10,463.2	6.7	4.6	11.1
Public	1,659.0	1,632.6	1,819.4	1,937.0	-1.6	11.4	18.6
Inventory variations	106.5	95.5	287.0	230.3	-10.3	200.5	141.2
Exports of goods and services	18,892.6	22,016.9	25,345.8	25,693.2	16.5	15.1	16.7
Overall supply	84,898.5	89,439.8	96,081.2	97,100.6	5.3	7.4	8.6
Imports of goods and services	29,015.1	32,455.2	36,550.4	37,855.7	11.9	12.6	16.6
Gross Domestic Product	55,883.4	56,984.6	59,530.8	59,244.9	2.0	4.5	4.0
Farming	7,205.1	7,145.9	7,403.0	7,207.0	-0.8	3.6	0.9
Mining and quarrying	242.6	249.9	262.3	262.4	3.0	5.0	5.0
Manufacturing industries	12,655.3	13,225.8	14,109.9	14,079.8	4.5	6.7	6.5
Water and electricity	350.2	354.3	374.4	358.6	1.2	5.7	1.2
Construction	2,176.6	2,126.5	2,243.4	2,373.1	-2.3	5.5	11.6
Commerce, hotels, and restaurants	10,940.9	11,030.8	11,370.7	11,259.9	0.8	3.1	2.1
Transportation, storage, and communications	4,554.8	4,836.6	5,124.8	5,124.2	6.2	6.0	5.9
Banking, insurance, and other financial institutions	2,098.4	2,205.2	2,337.5	2,337.3	5.1	6.0	6.0
Real estate and business services a/	1,811.4	1,838.6	1,893.7	1,912.5	1.5	3.0	4.0
Housing rentals	4,719.4	4,790.2	4,876.4	4,901.2	1.5	1.8	2.3
Community, social, personal, and domestic services b/	2,889.7	2,928.3	2,982.1	2,942.0	1.3	1.8	0.5
Government services	3,093.1	3,099.3	3,145.8	3,081.2	0.2	1.5	-0.6
Minus							
Attributed banking services	1,825.6	1,918.7	2,005.0	2,005.1	5.1	4.5	4.5
Plus							
Customs duties and VAT	4,971.5	5,071.9	5,411.7	5,410.9	2.0	6.7	6.7

Source: ECLAC, based on official figures

a/ Includes leasing and use of non-residential properties; professional legal, accounting, and audit services; preparation of data, computer services, architectural services, and advertising.

b/ Includes private education and health services, entertainment services (cinema and television) and other services such as veterinary services; trade, professional, labor, and religious associations; electrical repair shops and workshops for motor vehicles, watches, jewelry, etc.

In other words, the effect of the second earthquake was to further strain not only public finances, but also domestic savings and investment capacity. Such a significant increase in reconstruction expenditure will only come about if external resources can be obtained on preferential terms through loans made mainly by the Central American Bank for Economic Integration (CABEI), the Inter-American Development Bank (IDB) and the World Bank.⁷

⁷ According to the Central Reserve Bank and the IMF, the preferential terms for these loans are a 20-year period, a 5-year grace period and an annual interest rate of 7.5 percent (LIBOR). This suggests that there will be no significant rise in short-term debt during the three years following 2001.

We considered it useful to present three scenarios based on the estimated damage caused by both earthquakes. They are based on the following increases to the economy's historical investment rates: Scenario 1) 150 million dollars in the first year and an average of more than 400 million dollars a year for the following four years until reconstruction is completed; Scenario 2) an average of 380 million dollars for five years; and Scenario 3) 400 million dollars in the first year and an average of 375 million dollars a year for four years.⁸ This will determine the level of public expenditure and investment. It will depend on the terms of the country's debt in the next few years and its feasibility will be associated with the national productive structure's ability to expand. The length of time that the reconstruction phase lasts is another factor that might change, and with the cumulative effect of the second earthquake, it could easily continue for more than five years.

Table 4

SUMMARY OF MAIN ECONOMIC INDICATORS IN THREE
RECONSTRUCTION SCENARIOS FOR 2001 AFTER THE EARTHQUAKES OF
13 FEBRUARY

	Scenario 1 (pessimistic)	Scenario 2 (probable)	Scenario 3 (optimistic)
Real GDP growth	3.0%	3.5-4.0%	4.0-5.0%
Inflation	4.3%	3.0%	3.0%
Fiscal deficit	5.0-5.5%	4.8-5.0%	2.7-3.0%
Current account deficit/GDP	4.0%	3.5%	2.5%
Public debt/GDP	35%	33%	32.3%

Source: prepared by ECLAC. All the scenarios assume that loans will be made on preferential terms, especially with regard to interest rates and grace periods: 7½ percent annual interest over 20 years with a five-year grace period.

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Pessimistic Scenario: prepared on the basis of 150 million dollars for reconstruction in 2001, with a further 1.750 billion dollars in 2002-2005. Although real GDP growth is greater than in 2000, the reduced flow of resources for reconstruction in 2001 would not be enough to give a boost to the production sector and would cause a marked deterioration in the main economic indicators.

Probable Scenario: prepared on the basis of 380 million dollars for reconstruction in 2001 and 1.520 billion dollars in 2002-2005. This scenario would double 2000's GDP growth rate and reduce annual inflation. New reconstruction work and higher imports would increase the fiscal and current account deficits, respectively. It is estimated that the underlying deficit would be 2.7 percent of GDP, while reconstruction expenditure would be 2.1 percent of GDP, for an overall deficit in 2001 of 4.8 percent of GDP.

Optimistic Scenario: prepared on the basis of 400 million dollars for reconstruction in 2001 and 1.5 billion dollars in 2002-2005. Under this scenario, GDP growth would increase, inflation would be lower than in 2000 and the fiscal and external sector accounts would be kept at prudent levels.

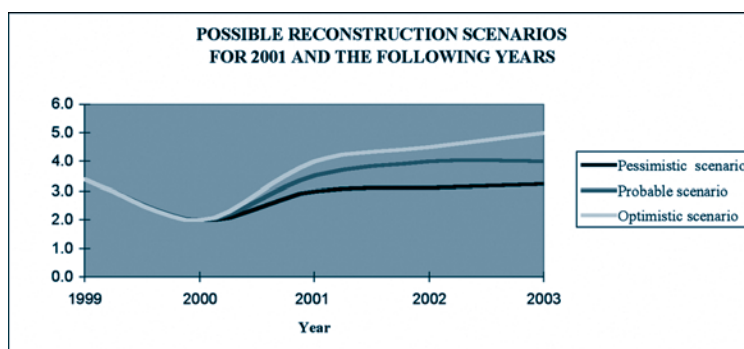
⁸ Changes in interest rates and reconstruction loan conditions could cause changes in the cost of servicing the fresh debt. The concessions obtained may not only favour a swifter reconstruction process, but also create fewer pressures on the basic macroeconomic balances.

These scenarios are of assistance in measuring possible impacts on the main economic indicators. However at the time of preparing the second assessment, it was still not possible to specify the amount of aid that might be received, the financing that would be available for 2001, when disbursement and implementation will take place or whether these loans would be made on the preferential terms mentioned previously.

This assessment does not include the effect of the possible use of alternative means of partially financing reconstruction, such as the sale of concessions or shareholdings in privatized businesses. Another possible source of financing should be increased domestic savings and tax revenues. This would lessen the strain produced by increased public expenditure –both current spending (in the emergency and for immediate rehabilitation) and investment spending (during the five or more years that reconstruction is expected to last).

Figure 1 shows GDP growth rates for each of these three scenarios.

Figure 1



As noted, the costs of reconstruction are over 1.9 billion dollars. This adds to the challenge already posed to economic policy by the first earthquake. Additional resources and appropriate management of public finances are needed to finance the national reconstruction plan and, at the same time, keep international reserves at an adequate level, control debt servicing costs and avoid further risks of macroeconomic instability.⁹ All this has to be done without producing any negative effects on production capacity and employment, which have already been harmed by the earthquakes.

⁹ These funds could be generated by a basket that could be made up of concessionary loans from multilateral bodies, bond issues, own resources and fiscal measures designed to broaden the taxpayer base and improve tax collection and the efficiency of the revenue authorities. The recent amendment to the tax code, which tackles the country's traditional problems of tax avoidance and evasion, might make tax collection more efficient.

Surveys of business activity carried out after the two earthquakes, together with the expectations of different business sectors, do not conclusively support the view that an increase in tax revenues can be obtained in 2001.¹⁰ Their stated perception was that internal demand could fall unless there were a recovery in income and employment. In addition, a potential increase in demand for resources for reconstruction could reduce demand in other areas. Reconstruction would bring a relative increase in current expenditure that could have a negative effect on the forecast rates of growth in social and capital expenditure, precisely because of the costs incurred during the emergency stage of the earthquakes and the financing of the 2001 “winter plan” (emergency measures to provide temporary housing and stabilize hillsides before the start of the rainy season).

In any of these possible reconstruction scenarios, the public sector deficit would be financed by the new loans, even in a scenario in which the Central Bank continued amassing international currency because of the potential increase in family remittances. The previous situation will be aggravated the more that reconstruction is financed by increasing the level of medium- and long-term debt. In the probable scenario, the overall cost of debt servicing could reach 33 percent of annual GDP, which is a reasonable level.

4. The impact on employment

- 96 Since the impact of the second earthquake was more localized than the first one, the effects on employment are more directly related to damage caused to the productive sectors of San Vicente, Cuscatlán and La Paz (especially small and micro - commerce). It is believed that the second earthquake had a much lower impact on the agricultural and maquila sectors, and damage was concentrated on rural and semi-urban sectors that used their homes as production centers. Consequently, the figures contained in the first assessment can be used as a basic reference, since they do not forecast changes in the major relationships and magnitudes caused by the second earthquake.

According to figures provided by the Coffee Council of El Salvador, more than 8 900 jobs have been lost as a result of the second earthquake, 43 percent of them in the San Vicente department; 13 percent in La Paz; 9 percent in Cuscatlán and other departments, such as San Salvador. Also, according to figures provided by the Chamber of Agriculture (CAMAGRO), more than 400 Lake Ilopango fishermen were affected.

Because a large number of the people engaged in these family, small, and micro - businesses are women, this population group will be particularly affected.

¹⁰ The surveys were undertaken by the El Salvador Foundation for Economic and Social Development (FUSADES), the National Private Enterprise Association (ANEP) and the El Salvador Chamber of Commerce and Industry.

The impact on employment was once again concentrated on small and medium-sized enterprises. The second earthquake increased the unemployment rates in San Vicente (7.3%), Cuscatlán (6.9%) and La Paz (6.3%). It also put more jobs at risk in these departments and destroyed production enterprises.

The first earthquake was responsible for the loss of 484 jobs in coffee plantations and 630 in coffee processing plants. Both figures were increased by the second earthquake (see above).

APPENDIX XVII

TWO EXAMPLES OF MODELS APPLICABLE FOR ESTIMATING THE IMPACT OF DISASTERS AND FORECASTING THEIR SHORT- AND MEDIUM-TERM CONSEQUENCES

Model A

Basic theoretical assumptions:

This is a simplified and improved version of the model used mainly by the International Monetary Fund (IMF) to estimate the impact of a natural disaster on GDP and the main macroeconomic variables.¹¹ The underlying assumption of Model A is based on empirical observation. This shows that although natural disasters usually have a very severe negative impact on the rate of economic growth in the immediate aftermath (a year, say), the growth rate tends to recover relatively quickly in the succeeding period. It is assumed that, other things being equal, the swiftness and size of the recovery in growth rate is a direct function of the capacity to replace the assets destroyed by the disaster and, more generally, of the reconstruction process itself.

98 In this model, it is assumed that the higher growth rate in the years following a natural disaster does not necessarily replace or return the well - being lost in the disaster within the medium (three to five years) or long (eight to ten years) terms. This is related to the conditional convergence hypothesis of growth theory, which postulates that the poorest countries (with less capital stock) tend to grow more quickly than developed countries (with greater capital stock).¹²

The first assumption in this model is a function of added production for the entire economy at a general level; a different function may be adopted, depending on the type of disaster and the type of economy. For the sake of simplicity, a Cobb-Douglas function with constant scale returns is assumed:

$$Y = AK^{\alpha}L^{\beta}$$

where:

$$y = \frac{Y}{L} \quad 0 < \alpha < 1 = \frac{K}{L}$$

Y is the product of GDP, K is the capital stock, L is the labor stock and A is a technological parameter that includes a trend variable as well as variables of external competitiveness and of human capital accumulation levels (total productivity of the factors).

The estimate is made using an error correction model that identifies the growth determinants with panel regression results from the Cobb-Douglas production function described above. The structural factors affect the technological variable and the macroeconomy, while prospects explain deviations from the long-term trend.

¹¹ Some of the improvements to the model were proposed in the course of ECLAC's damage assessment of the earthquakes in El Salvador at the beginning of 2001. The IMF's original model has no error correction mechanism and the GDP growth rate is plotted from estimates of expenditure and the magnitude of the fiscal gap.

¹² Robert Barro and Xavier Sala-i-Martin (1995), *Economic Growth*.

The model makes it possible to include information about long-term balance factors and also allows the information to be given an important role in specifying the dynamic structure. It also identifies the long-term determinants of total factor productivity in a context of balanced relationships provided by a technological production function. Short-term deviations are the result of factors that have been triggered when the long-term balanced relationship has not been fulfilled. Their magnitude is explained by stationary variables.

In general, the model sets certain requirements about the way in which the variables and the parameters are grouped. At the same time, this functions as a test of the reliability of the results and provides information about the growth trend and the nature of the economic cycle.

The following is a brief explanation of the error-correction model:

- A fundamental characteristic of co-integrated variables is that their short-term deviations tend to diminish in the long term. Therefore, it seems reasonable to suppose that there must be a co integration relationship between, for example, two variables Y_t and X_t :

$$Y_t = \beta X_t + \varepsilon_t \quad (1)$$

- There will probably be short-term imbalances between the variables, which the following VAR model of autoregressive vectors could explain (unless they are white noise, short-term changes can be estimated using an ARMA model):

$$\Delta X_t = \sum_{i=1}^n \alpha_{11}(i) \Delta X_{t-i} + \sum_{i=1}^n \alpha_{12}(i) \Delta Y_{t-i} + \varepsilon X_t \quad (2)$$

$$\Delta Y_t = \sum_{i=1}^n \alpha_{21}(i) \Delta Y_{t-i} + \sum_{i=1}^n \alpha_{22}(i) \Delta X_{t-i} + \varepsilon Y_t \quad (3)$$

However, since the variables function over a long term, the previous VAR does not include this knowledge and might not correctly identify the way that they should behave in the short term. Therefore an error correction model should be included:

$$\Delta X_t = \alpha_X(Y_{t-1} - \beta X_{t-1}) + \sum_{i=1}^n \alpha_{11}(i) \Delta X_{t-i} + \sum_{i=1}^n \alpha_{12}(i) \Delta Y_{t-i} + \varepsilon X_t \quad (4)$$

$$\Delta Y_t = \alpha_Y(X_{t-1} - \beta X_{t-1}) + \sum_{i=1}^n \alpha_{21}(i) \Delta Y_{t-i} + \sum_{i=1}^n \alpha_{22}(i) \Delta X_{t-i} + \varepsilon Y_t \quad (5)$$

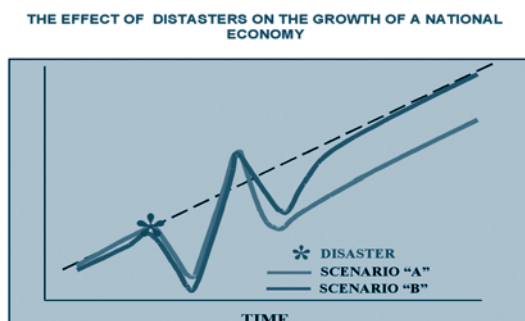
With this correction, a differential between the short and long-term variables should be corrected when the value of the variables t-1 to t is changed, provided there is equilibrium between the variables. For example, if Y_t rose in relationship to X_t in t-1, then in equation (4), X_t in t would be expected to rise ($\alpha_X > 0$). In equation (5) Y_t would be expected to fall ($\alpha_Y < 0$) in t.

Both α_X and α_Y are known as the equilibrium adjustment speed. Either of the two may have a value of zero, but not both at the same time. Therefore if $\alpha_Y = 0$, we can conclude that the imbalance adjustments could only be corrected through X_t and also that if all the $\alpha_{21}(i)=0$, then there would only be Granger causality from Y_t to X_t and not vice versa.

This model is based on the work of J.M. Albala-Bertrand (1993), which proposes a macroeconomic model to measure the impact of a natural disaster.¹³

Under this model it is assumed that the effects of a natural disaster are geographically localized, and that only rarely do they have a negative impact on added output. In fact, at least in the short term, their effects on GDP seem to be positive. Basically, the model postulates that the effects of a natural disaster “are a problem of development, not a problem for development”. The central argument is that even when the amount of total damage is large in relationship to GDP, this is not an obstacle to an economy’s growth. The model distinguishes between disasters whose impact is immediate (earthquakes, floods) and those with a slow impact (droughts). It is not applicable to man-made disasters (wars, technological failures, etc.). Despite such arguments, ECLAC’s experience over more than thirty years of disaster assessment in the developing countries of Latin America and the Caribbean shows that disasters are a problem both for and of development, in the sense that the response capacity and resilience to these events entail changes to existing structures and institutions. Otherwise, the positive effects of disasters on growth and output are constrained by the availability of resources budgeted for these events (disaster or prevention/mitigation funds). Where developing economies were suffering from shortages before the disaster, the resources allocated for attention and reconstruction not only compete with pre-existing development projects, but also add an extra burden that states cannot carry by themselves or that they are incapable of absorbing. The result is that after every disaster the gap between the level of growth expected and that achieved grows wider (see the following figure).

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Both in the model and analytically, a natural disaster consists of three elements: The impact of the disaster, the response to the disaster and the disaster’s incidental interference. The analysis is centered on the disaster’s impact on both growth and the loss of capital and output. A disaster is considered to be of great magnitude when the ratio of total damage to GDP is comparable to an economy’s growth rate (for example, five percent). However, this parameter should be used with caution, since a smaller damage ratio can also imply severe economic effects if the damage is localized in a key area of economic activity.

¹³ For further information, see World Development, Vol. 21, N° 9, pp.1417-1434, 1993.

This model assumes several rules for the behavior of disasters and their assessment, the last three of which are rendered questionable or invalid in the light of ECLAC's empirical observation.¹⁴ If recent experience shows anything, it is that damage is not necessarily overstated for political reasons. On the contrary, there are many recent examples of countries which have attempted to minimize the damage in order to maintain strict macroeconomic or fiscal discipline or which, for electoral reasons, have denied the existence of negative impacts, especially on vulnerable social sectors. In cases like that of Hurricane Mitch, the stability of macroeconomic variables was severely strained. It also seems that disasters are happening more often and that their consequences are increasing with every one. This is especially so with hydro-meteorological disasters, which could be linked to climatic change.

Because of the above, in methodological terms, a model enabling the identification of the upper limit of the disaster's impact on output is considered useful. This is a five-part process. The following is assumed that at the time of assessment:

- I. The emergency stage is either very advanced or has finished
- II. Materials are available;
- III. The capital stock lost cannot be replaced in the short term;
- IV. All the losses are of capital stock. and
- V. Capital stock is homogeneous

Given (IV) and (V):

$$\Delta K = D \Rightarrow \Delta K = Ka - Kb \quad (1)$$

Where K is the capital, D is the damage or total loss caused by the disaster, b is the impact before the disaster and a is the impact after the disaster. Assuming that the overall capital-output ratio is the same as for the total damage ratio, then:

$$c = K/Y = \Delta K / \Delta Y \quad (2)$$

where c is the capital-output ratio

$\Delta Y = Y_a - Y_b$ (daño esperado en el producto)

Y = producto (ingreso)

Solving (2) by ΔY y substituyendo ΔK por D :

14 The model is based on six "rules" or assumptions:

Rule I: Specific localization. Disasters only affect a "geographically" or "economically" localized area of activity.

Rule II: Internal effect differentiation. Neither the disaster's magnitude nor the social vulnerability at a particular disaster magnitude are the same throughout the disaster area.

14 Corollary II(a): Local sectoral coexistence. In the disaster area, affected economic units will coexist internally, with unaffected units belonging to the same economic sector.

Corollary II(b): Disasters have a greater effect on the poorer sectors (or on the poorest units within the sectors) of society.

Rule III: Differentiated damage to capital stock. The different types of capital stock are not equally affected by disasters. In fact, the distribution pattern for capital loss depends on the type of disaster

$$\Delta Y = D/c \quad (3)$$

Transforming (3) in growth rate and dividing both sides by Y:

$$y = d / c \quad (4)$$

Where $y = \Delta Y/Y$: output growth rate (fall) and $d = D/Y$ is the total damage/output ratio.

Consequently, the expected fall in the output growth rate (y) is in direct proportion to the total damage/total output ratio (d) and in inverse proportion to capital/output ratio (c). If assumption (iv) is removed, then $\Delta K < D$, since part of the damage corresponds to loss of output and not only to capital stock. This means that ΔK is heterogeneous, and c must be revalued in accordance with the productivities of the different types of capital stock. Therefore, other factors must be included in (4) to set a realistic value for the bottom level and consequently for an interval of the expected fall in the output growth rate:

- i. Not all disaster damage is to capital stock;
- ii. As a rule, disaster damage is overestimated;
- iii. Losses to capital stock are normally estimated at replacement cost;
- iv. All types of capital stock are heterogeneous in terms of production;
- v. Output growth does not depend exclusively on physical stock.

102 The first three factors affect the numerator in (4); the others affect the denominator. The resulting equation gives the bottom level of the expected reduction in the GDP growth rate. Removing assumption (iv) and incorporating factor (i):

$$D = D_1 + D_0 \quad (5)$$

where D_1 is total damage to capital and D_0 is total damage to production. Restating (1):

$$\Delta K = D - D_0 = D_1 \quad (6)$$

Since the cost of capital is calculated at replacement cost (factor iii), depreciation is subtracted to assess the present damage or loss of productive potential resulting from the capital loss. If this were not done, the effect on capital loss would be overestimated. Therefore:

$$D_3 = \pi D_2 = \pi D_1 \quad (7)$$

14 Rule IV: Overestimation of damage. It is assumed that the total amount of damage is overestimated for political and technical reasons.

Rule V: GDP stability and inflation. It is assumed that disasters do not have a strong negative effect on GDP and inflation.

Rule VI: Probability of disasters. Disasters are scarce and occur only occasionally.

Where D_3 is the present cost of capital loss, B is the reciprocal of the rate of depreciation, and T is depreciation. For example, $\pi = 1 - \lambda$ and $\lambda = T/D_2$. Correcting D_2 in (8):

$$\Delta K = D_3 = \pi D_2 = \pi D_1 \quad (8)$$

Since capital is heterogeneous in all types of stock (factor iv) and (in accordance with rule III) the least productive types of stock are generally the ones most affected by disasters, the average capital/output ratio where there is capital loss would be greater (i.e., less productive) than the overall average. This differential impact is incorporated by multiplying c by a ratio that, if rule II applies, will be greater than 1. However, if empirical evidence makes this rule inapplicable, its value could be equal to or less than 1:

$$c_1 = \alpha c \quad (9)$$

where c_1 is the capital/output ratio corrected by factor (iv).

Since capital is heterogeneous in all types of stock (factor v) and, according to the composition of the capital losses, more or less productive than any type (rule II and corollaries IIa and IIb), the average capital/output ratio for capital loss will be different from the overall average. This is incorporated by multiplying c_1 by a coefficient that will be determined for each case (greater than 1 if damage is caused to the least productive capital; otherwise, less than 1):

$$c_2 = \beta c_1 = \alpha \beta c \quad (10)$$

Where c_2 is the capital/output ratio corrected in accordance with factor (v).

Finally, since output does not depend exclusively on the contribution of capital, the contribution of the non-capital factors (factor v) is corrected by multiplying c_2 by a factor greater than 1, such that:

$$c_3 = \gamma c_2 = \gamma \beta c_1 = \gamma \alpha \beta c \quad (11)$$

Where c_3 is the capital/output ratio multiplied by the contribution of the non-capital factor. When all the corrections are incorporated in to (4):

$$y = d_3/c_3 \quad (12)$$

To state it in another way:

$$y = (\pi \epsilon / \alpha \beta \gamma) (d - d_0)/c \quad (13)$$

Since this is the lower limit of the expected fall in the output growth rate due to a natural disaster, the interval is expressed as:

$$d_3/c_3 \leq y < d/c \text{ (expected loss interval)} \quad (14)$$

This model enables the estimation of how much investment (or expenditure) should increase to compensate exactly for the expected loss or damage to output. The model includes three additional assumptions:

vi. Since the main purpose of any post-disaster response is to replace capital (reconstruction investment), the contributions made to replace indirect losses (in flows) are limited;

vii. Although reconstruction investment represents autonomous capital expenditure, it nevertheless competes with alternative uses for the resources; and

viii. There has to be sufficient idle capacity in the economy, especially in the construction sector.

Therefore:

$$\Delta Y = m \Delta K I_r \quad (15)$$

where m is the multiplier, I_r is reconstruction investment, Y is income (output), Δ is the variation and $m \geq 1$. Dividing equation (5) on both sides by Y :

$$y = m \Delta v \quad (16)$$

104 where $v = I_r/Y$ is the investment ratio. This means that when $m \geq 1$, for each unit of variation in the investment ratio (v) the output growth rate (y) can be expected to increase by m .

If reconstruction work is expected to last for several years, then equation (14) can be made to equal (13) such that:

$$\Delta v = d_3/mc_3 \text{ (compensatory investment ratio)}$$

The above represents the minimum increase in the investment ratio needed to fully compensate for the expected fall in output growth rate (capital lost or damaged) in the first year following the disaster. It is known as the compensatory investment ratio.

To calculate the minimum compensatory investment required, the following assumption is added to the model:

ix. The new capital is at least of the same quality as the lost capital. In fact, if mitigation and vulnerability criteria are included, it will necessarily be of greater quality.

At the end of the first year, the reconstruction investment ratio for that year Δv_1 should be deducted from the damage or total capital loss ratio. The compensatory investment ratio for the second year will now be:

$$\Delta v_2 = \frac{d_3 - \Delta v_1}{mc_3} \quad (17)$$

In this way, it can be generalized for the following year or derived as a geometrical series.

The series decreases and converges to zero as it tends toward infinity. The significant thing about this approach is that reconstruction can take place over several years without negative consequences for output or sacrificing funds for other development projects. Of course this will depend on the values of the multiplier (m), the corrected capital/output ratio (c_3) and the corrected capital damage ratio (d_3). With this, it is easy to demonstrate that the greater the value of the multiplier and the capital/output ratio, the smaller the value of $1/mc_3$ and the nearer to unity the ratio r . The closer this ratio gets to 1, the smaller the reconstruction investment required for any particular year.

In the first year, in addition to the investment expenditure, there is a part of total damage which corresponds to current GDP and which must be compensated for once only and at the same time. If the income multipliers are symmetrical and the disaster's impact tends to lead to contraction while the response to the disaster promotes expansion, then the same amount of additional expenditure will be needed to compensate for the loss of current income. Nevertheless, as the impact multipliers are expected to be lower than the response multipliers, compensatory expenditure is only a part of the loss of current income. Therefore, the amount of compensatory expenditure required in the first year would be:

$$\Delta e_1 = (m_1 / m_2) d_0 + \Delta v_1 \quad (18)$$

where e_1 is the total first year expenditure ratio, v_1 is the minimum compensatory investment ratio in the first year, d_0 is the current output loss ratio, m_1 is the impact multiplier and m_2 is the response multiplier.

V. EMPLOYMENT AND INCOME

1. Introduction

It is very difficult to quickly gauge a disaster's possible impact on employment and income. One must begin by using the available sources to determine the extent to which the labor force of the affected country or region's employment and income was at risk.

Then the analyst must use field studies to assess the post-disaster state situation of jobs and employment generation in the key sectors of the economy in the affected region. Later, he/she must determine the best time to conduct a much more precise and detailed evaluation while making sure that such painstaking endeavors are completed in time for the results to be delivered to policy makers in charge of drawing up repair and reconstruction plans and programme.¹

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Timely assessments are key to ensuring that policy makers can focus actions on the most affected areas and sectors. The dynamics of employment recovery are not simply a variable of indirect adjustment (i.e., a product of investment in reconstruction); to achieve the greatest impact, programs must take into account where, to what extent and which sectors have been affected. Such an approach is essential for stemming the migratory flows frequently sparked by delays in employment recovery. Such migration tends to contribute to expanding the poverty belts around urban areas and to rendering more precarious the options available to these population groups to undertake their own micro process of family reconstruction, a subject not covered in macroeconomic disaster analysis.

2. Estimation of the overall impact on vulnerable employment

A preliminary response to the problem requires an estimate of the population exposed to disaster damage in terms of employment vulnerability. An approximation may be obtained by comparing data on the economically active population (EAP) of the affected areas against the impact on housing and the population, and with such vulnerability indicators as those measuring poverty, unemployment, and female employment.

The procedure to be followed involves determining the dimensions of the percentage of primary and secondary affected population. This will allow the analyst to ascertain the exposed EAP (those suffering direct loss of employment, reduction in income or a future loss or reduction of income). The exposed EAP is estimated as the total EAP of the affected area, multiplied by the percentage of primary and secondary affected population

¹ The timing of such research will depend on the extent of access to and communication with the affected area; furthermore, analysts should avoid bombarding disaster victims with multiple surveys and questionnaires during critical moments of the emergency period.

One must then determine the vulnerable EAP by combining the figure on exposed EAP and the percentage of total poverty or poverty index.

Later, it is necessary to determine the factors aggravating employment and income vulnerability. This requires information on the percentages of female employment, general unemployment and the damage to housing within the affected areas. The population's vulnerability is aggravated by such factors as the specific challenges faced by women workers employed outside the home, the difficulties in finding employment in the post-disaster situation and the economic burden of repairing and reconstructing housing.

The following table presents an example of an analysis of the global impact on employment and income, using the case of the January 13, 2001, earthquake in El Salvador to illustrate how to estimate the economically active population left vulnerable by a disaster.

Table 1
ESTIMATION OF THE ECONOMICALLY ACTIVE POPULATION VULNERABLE TO LOSS OF EMPLOYMENT AND INCOME IN EL SALVADOR AS A RESULT OF THE JANUARY 13, 2001, EARTHQUAKE

Departments	Primary secondary affected population	Exposed EAP	Total poverty	Vulnerable EAP	Factors aggravating vulnerability [*]		
	%		%		EAP/Women	Unemployment	Damaged housing
	%		%		%	%	%
Usulután	96.1	120,230.0	55.8	67,088.0	36.5	8.7	71.3
La Paz	76.0	82,624.0	49.3	40,734.0	38.0	6.3	63.0
La Libertad	21.2	57,093.0	32.9	18,783.0	42.4	6.5	20.4
Sonsonate	21.4	37,151.0	60.5	22,476.0	37.6	7.2	25.9
San Vicente	55.9	33,117.0	39.9	13,213.0	32.3	7.3	64.4
Ahuachapán	21.0	22,884.0	60.3	13,799.0	28.2	8.5	14.3
San Miguel	12.8	22,226.0	44.6	9,912.0	36.4	6.5	11.7
San Salvador	2.0	16,920.0	28.4	4,805.0	45.1	7.0	2.7
Santa Ana	6.9	14,892.0	45.7	6,846.0	36.3	7.7	6.2
Cuscatlán	18.1	14,349.0	39.9	5,725.0	41.8	6.9	20.6
TOTAL		421,486.0		203,381.0			

Source: ILO estimates based on official information and the mission's own estimates.

The above table shows the vulnerable EAP broken down by affected geopolitical unit. The basis for these calculations includes the prior determination of the primary and secondary affected population (as described in the chapter on affected population in Section Two of this Handbook) and the use of the poverty index (usually available in official statistics offices or in the human development reports presented by the United Nations Development Program UNDP). Furthermore, one must obtain information on paid female employment and total unemployment, which is generally contained from in the aforementioned sources. Lastly, the employment analyst must work closely with the team's housing and human settlements specialists to acquire the housing damage assessment.

2 Identifies the sector of the EAP that might have been affected by lost employment, fall in income, and income susceptible to loss or reduction. Estimated as: Total EAP x % of primary and secondary affected population.

3 Identifies the sector of exposed EAP whose poverty serves as a drag on recovery. Estimated as: Exposed EAP x poverty rate.

4 The conditions of working women, the difficulty of finding employment and the economic burden of rehabilitating or reconstructing dwellings aggravate the situation of vulnerability.

3. Estimates of losses of employment and income at the sectoral level

Occasionally it is possible to obtain or develop coefficients linking the volume or value of production lost in each sector with the number of jobs involved, but time constraints usually make such analysis impossible. Therefore, indirect procedures must be used to estimate loss of employment in each affected sector or activity, together with the job implications of reconstruction activities, which tend to expand demand for both skilled and unskilled labor.

Let us look at some examples of how to calculate or estimate employment and income loss for typical productive sectors; the employment specialist need make only minor adjustments to apply the same methodology to other sectors.

a. Micro, small and medium-sized enterprises (MSMEs)

In developing countries, dwellings commonly accommodate a range of productive activities that generate income for their occupants. Therefore, references to “productive homes” are common.

108 Among the lowest-income population groups, such productive homes may serve as informal markets, wholesale stores, service establishments and so forth. Damage to housing may interrupt such productive activities and lead to the total or partial loss of stocks or product inventories; meanwhile, transportation costs may be greatly magnified when access roads have been blocked or severely damaged. In addition to the resulting loss of sources of employment or income, other population groups run the risk of relative income erosion under the impact of greater costs, reduced supply and price speculation on inputs and basic goods. Thanks to the timely distribution of food aid and relief supplies, price spikes and supply shortages generally do not appear until after the initial emergency stage, generally around the time reconstruction activities get underway. This means the affected population suffers a double penalty or loss as the cost of “family reconstruction” increases.

Estimating the loss of employment or income in this sector requires the availability of basic statistical information (normally available from business surveys of micro, small and medium-sized enterprises) regarding the number of people employed by type of enterprise and the relationship between the number of such enterprises and the housing accommodating them.⁵ Sometimes business associations conduct rapid surveys in the aftermath of a disaster to determine the damage suffered by members; ideally, these must be properly directed or at least coordinated by the mission’s employment specialist. The final picture can be filled out by combining the resulting data with the information produced by the housing and human settlements specialist about the number of dwellings damaged or destroyed. To this end, it is necessary to determine the wages paid and estimate the time required for production to recover in each kind of enterprise. Obviously, the employment specialist must cooperate closely with the specialist in productive sectors to produce these estimates.

⁵ For example, 1.5 employees per subsistence and simple-accumulation microenterprise; 3.5 employees per broad accumulation microenterprise; 25 employees per small enterprise. Moreover, statistics show that in this case there is one such enterprise for every 20 dwellings.

Our estimate example yields the following results:

- An average of 1.82 jobs per establishment in the 11 820 housing units destroyed that housed enterprises = 21 500 lost jobs;
- Thirty percent of jobs lost per establishment in the 20 218 damaged housing units that accommodate enterprises = 11 040 lost jobs;
- An additional 25% of jobs put at risk in the damaged 20 218 units = 9 200 jobs at risk;
- In the 30% of the establishments destroyed that are to be rebuilt in a three-month period, workers lose an average of 1.5 months' wages/income. In the 40% of establishments to be rebuilt in six months, workers lose an average of 4.5 months' income; in the 30% of establishments that are to be rebuilt after six months, income is lost during the first six months while income falls an average of 25% in the succeeding year. At a rate of one legal monthly minimum wage of 144 dollars, lost income totals 16 254 000 dollars.
- Fifty percent of establishments damaged are repaired in the first six months, with an average loss of three months' wages per employee; the remaining 50% are repaired in the following six months, with an average loss of six months per worker. Combining these figures with the same legal minimum wage, we arrive at a total loss of income of 7 153 900 dollars.

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The mission thus estimated that 32 540 jobs were lost and another 9 200 jobs are at risk, implying approximately 23.4 million dollars in lost income in the period of six to 18 months required for establishments to be repaired. The scope of the impact on women can be inferred as they accounted for 65% of those employed in the sector. The following table summarizes the results of the previous estimates, with losses broken down by geopolitical division.

Table 2

IMPACT ON THE EMPLOYMENT AND INCOME OF WORKERS IN MSMEs AFFECTED BY THE JANUARY 13, 2001, EARTHQUAKES IN EL SALVADOR

	Enterprises destroyed	Enterprises damaged	Jobs lost	Jobs at risk	Loss of wages, US\$
Usulután	3,880	3,398	8,345	2,359	6,117,887
La Paz	2,853	3,668	7,557	2,137	5,485,730
La Libertad	1,985	1,633	4,936	1,396	3,624,167
Sonsonate	1,404	2,242	1,852	524	1,270,555
San Vicente	477	3,801	3,047	862	2,071,840
Ahuachapán	87	440	351	99	242,233
San Miguel	582	2,510	2,975	841	2,066,072
San Salvador	175	842	1,020	288	702,281
Santa Ana	128	156	335	95	242,935
Cuscatlán	229	1,265	1,257	355	864,864
TOTAL COUNTRY			32,540	9,200	23,407,920

Sources: 99 Survey of homes (unpublished), 1998 Directory of establishments, 2001 CONAMPYE report, and ILO estimates based on the mission's complementary figures.

b. Agricultural sector

The impact on employment in the agricultural sector comprises two factors. The first consists of losses in production and farmland, as well as damage to infrastructure. The second has to do with a combination of indirect factors, such as the farm workers losing access to housing when farm work is suspended or partially curtailed.

The number of jobs lost in each agricultural productive activity must be inferred from the shortfall in production resulting from the disaster. This information is normally obtainable from agriculture ministries.

The figures above must be combined with the estimated recovery period and the impact on wage levels for each activity.

It is not possible to directly measure the impact on wages, making it very difficult to arrive at an estimate of jobs at risk in this sector.

The El Salvador mission made the following job-loss estimates:

- Coffee picking, 2 015 jobs;
- Work in coffee processing plants, 630 jobs;
- Artisan fishing, 1527 jobs;
- Irrigation districts, 1 240 jobs; and
- Dispersed small irrigation systems, 215 jobs.

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The following recovery estimates were made in line with the opinions of experts and local authorities:

- Twelve months for coffee picking, which in this case actually represents the period required for migrating other labor sectors, as non - disaster factors are expected to prevent a full recovery of activity;
- Six months for the repair of the coffee processing plants that were severely damaged, three months for those that were seriously damaged, and no impact for those that suffered less significant damage;
- Three months for the return of biomass to areas accessible to artisan fishermen, and to repair the sector's infrastructure; and
- Three months to repair irrigation districts and small irrigation systems.

Taking into account the wages paid in each activity, it was possible to estimate losses from the January 13, 2001, earthquake in El Salvador totaling 4 716 jobs and 2.9 million dollars in income (see the geopolitical distribution of these losses in the following table).

Table 3
EMPLOYMENT AND INCOME LOSSES IN THE AGRICULTURAL SECTOR CAUSED BY
THE JANUARY 13, 2001, EARTHQUAKE IN EL SALVADOR

Department	Totals		Irrigation districts		Small irrigation		Coffee processing plants		Coffee plantations		Fishing	
	Jobs	1,000 US\$	Jobs	1,000 US\$	Jobs	1,000 US\$	Jobs	1,000 US\$	Jobs	1,000 US\$	Jobs	1,000 US\$
National total	4,716	2,859	1,840	795	235	102	630	467	484	836	1,527	660
Usulután	1,166	571	515	223			70	52	35	60	546	236
La Paz	7	12							7	12		
La Libertad	2,691	1,687	1,325	572	76	33	440	320	305	527	545	235
Sonsonate	549	282			45	19	50	43	18	31	435	188
San Vicente	9	16							9	16		
Ahuachapán	165	94			114	49	50	43	1	2		
San Miguel	1	2							1	2		
San Salvador	20	9					20	9				
Santa Ana	108	187							108	187		

Source: ILO and ECLAC estimates based on official figures and own calculations

The examples above, taken from two key economic sectors in a developing country, provide guidelines on how to estimate disaster-related employment and income losses. In light of the huge variety of effects produced by different disasters, employment specialists –in close cooperation with housing and productive sector specialists– should adapt the procedures outlined here to specific situations.